Radio, Electronics and Communications

FORMERLY "RADIO & ELECTRICAL REVIEW" — WIDELY KNOWN SINCE 1946 AS "R. & E."

MPL

In This Issue . . .

- Microelectronics—The tiny shape of things to come.
- R.E. & C. 6in. TV Receiver.
- Magnetic Tape Data Recording.
- R.E. & C. "Three Plus R" Mantel Receiver.
- Circuits and Service Data.

PUBLISHED MONTHLY IN THE INTERESTS OF THE N.Z. ELECTRONICS INDUSTRY FOR ALL LEVELS, FROM PROFESSIONAL TO AMATEUR.

VOLUME 19 NUMBER 9

NOVEMBER 1, 1964

PRICE 2/6

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ENQUIRY CARD AD. 1

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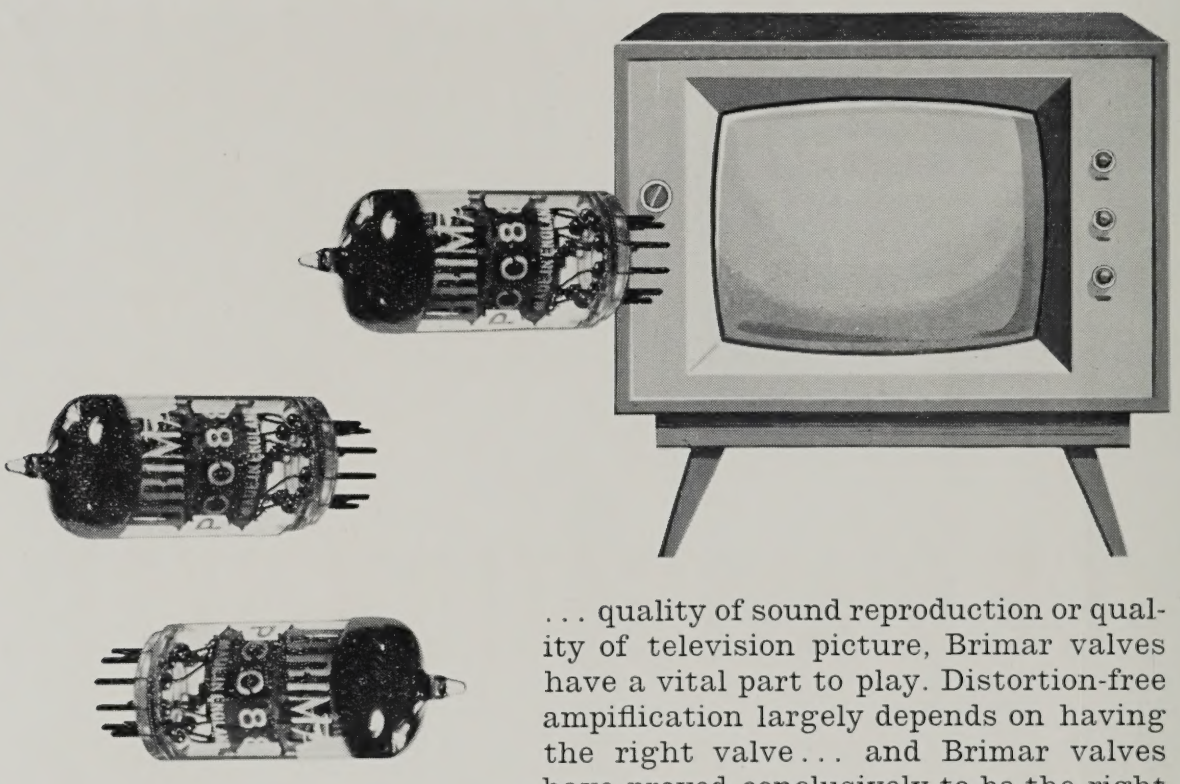

. . . quality of sound reproduction or quality of television picture, Brimar valves have a vital part to play. Distortion-free ampification largely depends on having the right valve . . . and Brimar valves have proved conclusively to be the right valves for today's exacting needs. When it comes to TV, Brimar Teletubes are equally 'in the picture'. No wonder Brimar valves are specified both by set manufacturers and for dealers' replacement purposes.

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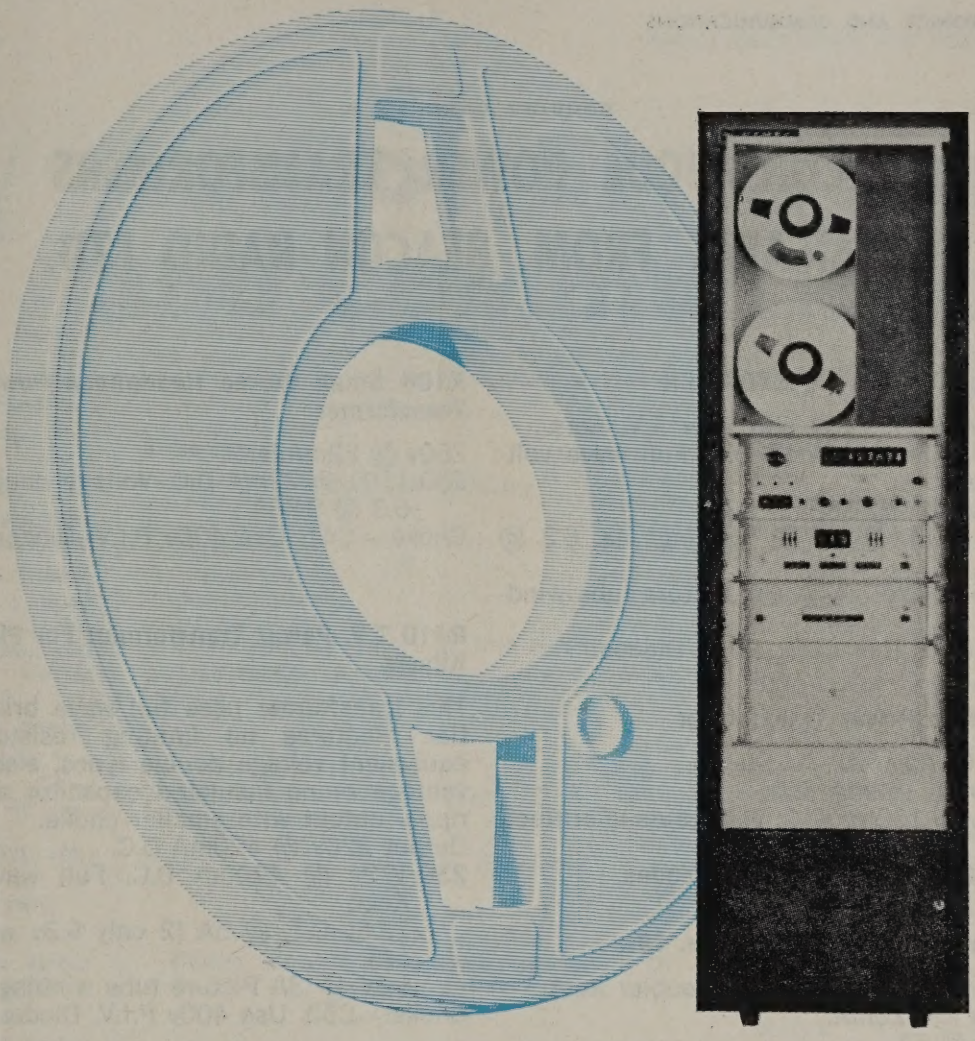

get speed and data density of magnetic tape . . .
—with new standard digital data acquisition systems!

ADD: The advantages of standard systems—complete system specifications, immediate delivery, proven reliability, low cost **TO:** The benefits of magnetic tape recording and data processing **AND GET:** Fast automatic measurement of dc volts, low-level dc, ac volts, resistance and frequency recorded on an incremental recorder in computer compatible format—as fast as 10 channels per second—with up to 440,000 unattended measurements and recordings.

Heart of these magnetic tape systems, as of other Dymec 2010 Data Acquisition Systems, is the DY-2401B Integrating Digital Voltmeter, a floated and guarded instrument which lets you measure extremely low-level signals even in the presence of severe common mode and superimposed noise. The 2401B measures dc voltages to 1000 volts with 300% overranging on the lower ranges. It also measures frequency 10 cps to 300 kc, and you can add an optional converter to measure ac and resistance.

The newest of Dymec's standard systems comes in two models, the 2010J and the 2010H, which differ only in scanning capability. With the 2010J you can measure up to 200 3-wire channels, or measure up to 100 channels with the 2010H System.

Now from nine standard systems you can select a wide variety of input capabilities and recorded output, including printed paper tape, punched tape, punched cards . . . and magnetic tape.

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ENQUIRY CARD AD. 3

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For R.T.V. & H. 1959 and later T.V. Sets.
Delivers 260v @ 300mA D.C. Full wave voltage doubler.
230:115v A.C. @ 300mA D.C.
:12.6v C.T. @ 5A (2 windings ea. 6.3 @ 5A).
:0—6.3—7.5—9 @ .6A. Picture tube winding.
Choke:—C36. Use 400v P.I.V. Diodes.

R103 Stereo Power Transformer

R.T.V. & H. Aug. 60. 7w Stereo.
230:245v @ 150mA. D.C.
:104v @ 150mA D.C. Voltage doubler Rect.
:6.3v C.T. @ 5A.
Choke:—C42. Use 400v P.I.V. Diodes.

R104 Stereo Power Transformer. 10w

320v @ 320mA. Voltage doubler Rect.
230:130v @ 320mA.
:6.3v @ 6A.
Choke:—C49. Use 500v P.I.V. Diodes.

R105 T.V. Power Transformer For Philips T.V. Kitsets

220v @ 420mA D.C. Voltage Doubler Rect.
230:106v @ 420mA D.C.
:6.3v @ 10A.
:0—6.3—7.5—9 Ov @ 0.3A. Picture tube Winding.
Choke:—C45. Use 400v P.I.V. Diodes.

R106 T.V. Power Transformer for Philips T.V. Kitsets

This type similar to R105 but less Picture Tube boost taps. Main Fils. 12.6v C.T. @ 5A.
220v @ 420mA D.C. Voltage Doubler Rect.
230:106v @ 420mA D.C.
:12.6v C.T. @ 5A (2 windings 6.30v @ 5A each).
:6.3v @ .3A Picture tube winding.
Choke:—C45. Use 400v P.I.V. Diodes.

R108 Small Stereo Headphone Power Transformer

250v @ 22mA D.C.
230:110v @ 22mA D.C. Voltage doubler Rect.
:6.3 @ 0.86A.
Choke:—C41. Use 400v P.I.V. Diodes.

R110 T.V. Power Transformer. For Philips T.V. Kitsets

This transformer uses full wave bridge rectifier. Requires no limiting resistor unlike equivalent voltage double types, also has advantage of no insulated capacitor and lower ripple output with smaller choke.
Output 220v @ 420mA D.C.
230:172v @ 420mA D.C. Full wave bridge Rect:
:12.6v C.T. @ 5A (2 only 6.3v winding @ 5A).
:6.3v @ .3A Picture tube winding.
Choke:—C50. Use 400v P.I.V. Diodes.

R111 T.V. Power Transformer

Similar to R110 but for R.C.A. type Kitsets.
260v @ 350mA from Rect.
230:207v @ 350mA D.C. Full wave bridge Rect.
:12.6v C.T. @ 5A (2 only 6.3v windings each 5A).
:6.3v @ 0.6A. Picture tube winding.
Choke:—C42. Use 400v P.I.V. Diodes.

R112 Oscilloscope Power Transformer

R.T.V. & H. 1963. Calibrated.
230:110v @ 80mA D.C. Full wave voltage doubler.
:6.3v @ 2.4A.
:6.3v @ 1A.
:6.3v @ 1A.
Use 400v P.I.V. Diodes.

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On Our Cover

V.O.R. NAVIGATION SYSTEM FOR AIRWAYS OPERATION FROM AWA

VHF Omni-Range — commonly known as VOR — is a principal component of the internationally adopted short-range navigation system for airways operation. The other measuring component is DME which system was the subject of a separate contract placed with AWA.

The illustration shows the 15-foot shelter which contains the Dual Silcox type 485A VOR equipment. The unique slot type antenna surmounts the shelter. VOR operation is based on phase comparison at the aircraft receiver. The ground equipment radiates two separate carriers, a reference carrier and a variable carrier, both originating from a common transmitter.

The two signals from the ground station have a co-relation between phase and degrees of azimuth around the station site.

The bearing of the VOR ground station is indicated to the pilot in degrees on a circular dial—needle pointer instrument calibrated 0—360 degrees.

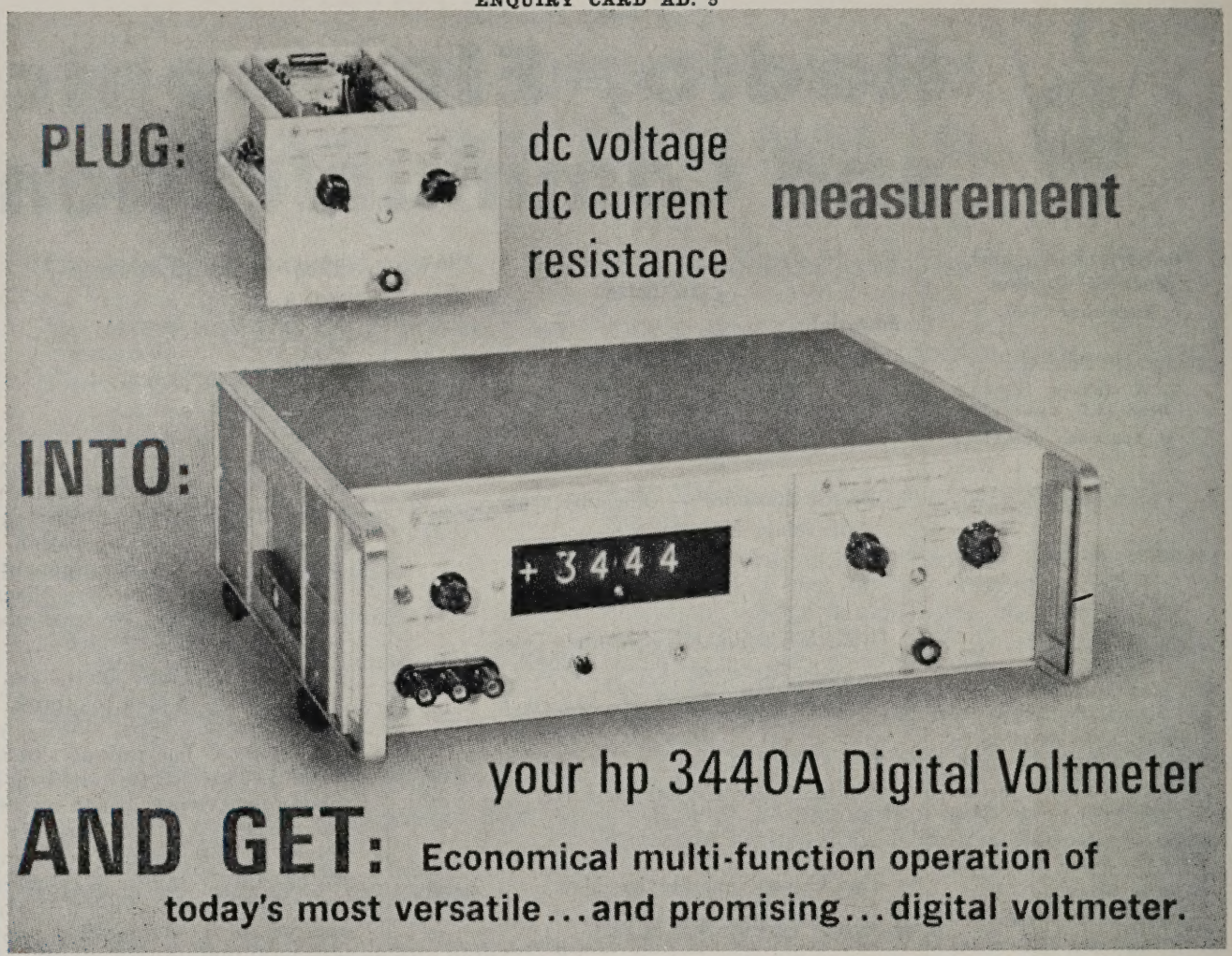
COMING . . .

R.E. & C. 5in. Experimental Television Receiver —Part II
Magnetic Tape Data Recording—Part II
New Zealand's Frequency Standard
A Transistorised Amplifier
The Space Link
Extended Range V.H.F.

Also . .

Book Reviews
New Products
Serviceman's Column

ENQUIRY CARD AD. 5



The new 3444A Multi-Function Unit provides measurement of dc voltage, 99.99 mv to 999.9 v; dc current, 99.99 μa to 999.9 ma, and resistance, 999.9 ohms to 9.999 megohms, each with 5% overranging. On voltage measurements, 10 μv resolution makes the plug-in ideal for low-level measurement; in current measurement, maximum sensitivity is 10 nanoamps; accuracy ±0.2% of reading ± 1 digit. Resistance measurements, too: ±0.3% of reading ±1 digit to 999.9 K ohms; ±1% of reading ±1 digit on 9.999 megohm range. Here's another step-up in the performance versatility of your high-value 3440A Voltmeter, which offers you all these features. Automatic measurement with 4-digit resolution, up to 5 readings/sec. Total error less than ±0.05% of reading for 3 highest ranges, ±0.1% ±1 digit for 100 and 1000 mv ranges. Automatic decimal and polarity; BCD recorder output; constant 10.2 megohm input impedance; floating input; display storage for non-blinking readings; solid-state circuitry; compact size.

PLUS: 3443A High Gain/Auto Range Plug-in, with 100 mv to 1000 v full scale ranges . . . 10 μv resolution; 3441A Manual Range Selector, 10, 100, 1000 v ranges, 3442A Automatic Range Selector, adding automatic ranging to the manual capability of the voltmeter.

With the 3440A DVM, prices are right, capabilities are designed to meet your particular problem right now . . . and in the future. More plug-ins to come. Why not check into it . . . with a call to your Hewlett-Packard field engineer or letter direct.

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Recent Standard Specifications

TUNNEL DIODES

The British Standards Institute has issued an amendment to B.S. 3494 **Memorandum on light-current semi-conductor devices** Part 1 **Essential ratings and characteristics.**

This gives details of the essential ratings and characteristics of tunnel diodes. This information is regarded as the minimum data which should be provided by a manufacturer when describing his product for general sale.

REQUIREMENTS FOR QUARTZ OSCILLATOR CRYSTAL UNITS

The first part of a British Standard for '**Quartz oscillator crystal units**' has been issued.

Part 1 of B.S. 2271 gives **General requirements and methods of test** for fundamental and overtone crystal units, to ensure their ability to withstand specified conditions of mechanical shock and vibration and their suitability for use or storage over stated ranges of temperature, humidity and pressure. The tests are also designed to assess the ability of the units to stand up to normal assembly processes such as soldering.

Appendices to Part 1 give the information to be provided by purchasers when ordering crystal units, and a list of the M.o.A. test sets which are recommended for the measurement of frequency and equivalent resistance.

ELECTRIC AND MAGNETIC QUANTITIES

IEC Publication 164 '**Recommendations in the field of quantities and units used in electricity,**' is a complete exposition of the work of the IEC in the field of electric and magnetic quantities and units.

It is divided into three sections: (1) the history of electric and magnetic quantities and units; (2) list in full of the recommendations of the IEC; (3) select bibliography. An appendix sets out the resolutions of the General Conference on weights and measures concerning electric and magnetic quantities and units.

SOUND DISTRIBUTION SYSTEMS

'**Telecommunication facilities in buildings,**' CP 327 is being revised and work is complete on part 3 for '**Sound distribution systems.**' This part was originally numbered CP 327 :300 and the numbering of the other sub-codes which make up the CP 327 series will be changed as they are revised.

Part 3 deals with sound distribution systems in buildings which are not designed primarily for sound reproduction. Some guidance is given on installations in open spaces. The code gives detailed guidance on materials, appliance, components, design considerations, structural accommodation, wiring, inspection, testing and maintenance, and aims to establish criteria for good performance and reproduction.

Copies of the above may be obtained from the New Zealand Standards Institute, Private Bag, Wellington, or through this journal.

Letters from Readers

Sir,

I wish to inquire if you have as yet published a circuit of a Pye El Greco model T20 TV set. If you have, what issue was it in and is a copy of that issue available. I would be obliged if you could let me know if a issue is available and also the cost.

J. O. ASHWORTH,
Lower Hutt.

Sir,

Could you please advise me if you have ever published the circuit diagrams of the following TV sets:

Model T20/233N — Pye
Model T18 — Pye

If so could you inform me of the dates of issue.

R. CARR,
Christchurch.

P.S.—If not I would appreciate an address where these could be obtained.

We thank you for your inquiries concerning our circuit and service feature. In both cases we are arranging for you to receive the information requested.

—Ed.

BACK COPIES OF R. & E., R.E. & C.

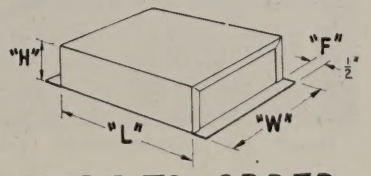
Periodically inquiries are received for back numbers of "Radio and Electrical." A few copies of the issues since the publication changed hands (i.e., April 1961) are available from the publishers: The Magazine Press Ltd., Lumley House, 10 High Street, Auckland (P.O. Box 1365).

ENGLISH COMPANY SPONSORS LECTURESHIP

The name of prominent London company, Dawe Instruments Ltd., brings back memories of the recent visit to N.Z. of Professor Richards of Southampton University. Dawe have sponsored the founding of a lectureship at Southampton's Institute of Sound and Vibration Research to foster research and teaching into noise measurement. Mr. P. L. Tanner, already prominent in the field, will serve under Professor Richard's directorship of the Institute.

ENQUIRY CARD AD. 8

BLANK CHASSIS



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(Corrosive resistant with twice the strength of Aluminium to B.S.S. 1470, NS5).
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Preferred height 2".
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WHEN ORDERING PLEASE STATE:
L x W x H x material gauge and whether inside or outside mounting flange.

Example of Single Prices:
7" x 3" x 2" x 20g. = 9/9
7" x 5" x 2" x 20g. = 10/6

Chassis in mild steel or in larger quantities can also be supplied.

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Cameron Rd. South, Greerton, Tauranga.

ENQUIRY CARD AD. 7

SEE HOW RCA RECEIVING TUBES KEEP GETTING BETTER

1959 —*N-132 Cathode Base Material*

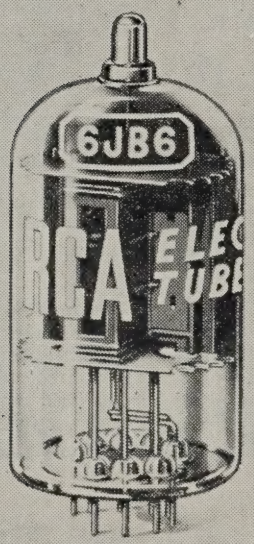
1960 —*S-311 Plate Material*

Virtually ideal black-body characteristics for most effective heat dissipation

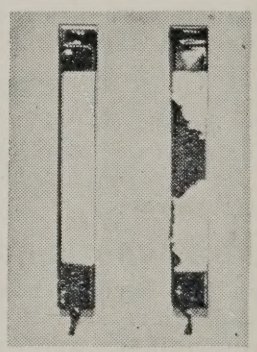
1961 —*Dark Heater*

Produces required cathode temperature at a heater temperature 200°K to 350°K below that of conventional heaters

***AND NOW* 1963...**



THE BONDED CATHODE



Ends cathode peeling, even after long periods of high-temperature, high-voltage tube operation.

Picture on right is an example of peeling which may occur in nonbonded cathode of a horizontal-deflection-amplifier tube after several hundred hours of operation in a TV receiver.

From RCA research, another major contribution to electron tube performance and reliability: the bonded cathode. Its emissive-oxide coating **will not peel** even after extended service under high-voltage, high-temperature conditions encountered in TV horizontal-deflection-amplifier tubes and damper diodes. Permanent adhesion of the emissive-oxide coating of the RCA bonded cathode improves over-all tube performance and reliability . . . with resultant extension of tube life. Here's why!

THE NEW RCA BONDED CATHODE:

- virtually eliminates peeling of emissive-oxide coating
- reduces grid-to-cathode shorts during life
- reduces cathode interface-type impedance effects during life
- improves stability of cathode-to-grid spacing
- improves anode-voltage-per-mil-spacing safety factor in damper diodes
- transmits heat more efficiently and uniformly — thereby providing more uniform cathode-current density.

The RCA bonded cathode was first applied with outstanding success in beam power tube types 6DQ6-B and 6JB6, and half-wave vacuum rectifier types 6AU4-GTA and 6AY3. This new development is now being incorporated in a growing number of types where service conditions indicate the need.

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VR25

The Universities and Industry

Late in September the Council of the University of Auckland issued a set of rules limiting the nature and amount of outside work that could be undertaken by that University's School of Engineering. In this issue will be found a news item concerning a British University which is collaborating with a company in the establishment of a lectureship in a specialised industrial field. Whatever the ultimate intent of the Auckland rules the statement in the daily press gave the impression that industry could look elsewhere for help. Perhaps not every day, but certainly every week, the old cry goes up in the press that universities are short of finance. In the field of science and engineering (the medical sciences excluded) we do not know of one lectureship, let alone chair, endowed or even fractionally supported by industry in this country.

What is the difference between the case in New Zealand and, say, the University of Southampton? The answer has been given recently by an officer of the Department of Scientific and Industrial Research who has just returned home after a trip overseas. The universities here do not interest themselves in the problems of industry. Reading between the lines of his reported statement the implication was that the universities do not even realise that problems exist in industry that they could well help solve.

This, of course, immediately raises the question as to the nature and function of the universities in this country. Are they still "force feeding" houses churning out book-learned graduates still wet behind the industrial ears. Certainly the reluctance to include any compulsory basic humanities in science or engineering courses would point to the state of affairs often termed a "degree factory" outlook.

There are at least ten or twelve industrial concerns in this country sufficiently large and affluent enough to give some form of continuing support to the science and engineering faculties of our principal universities. In fact, we would be fairly certain that those ten or twelve are larger, in all senses, than the London company mentioned in our news item. The burden of a lecturer's salary, say, £2000 per annum, would be almost unnoticed. However, to be frank about it and excepting Canterbury University with their Industrial Laboratories, we do not think any university at present **deserves** such consideration if the Auckland attitude is to be taken as typical.

At least half the engineering and science graduates hope to obtain positions in private industry rather than State or semi-State service but pitifully few have any real knowledge of the problems in industry — human and mechanical. Worse still, their lecturers have lost, or if they are newly appointed, are losing touch with industry. One looks hard to find them at Institutional meetings and surprisingly few publish papers in professional journals—is this lack of interest and original thought or lack of time? State servants (N.Z.P.O. and M.O.W., etc.) publish frequently and are sorely pressed for time, and broadly speaking their papers are of current interest and immediate value—"this is the problem, here is a solution."

To broaden our economy we must make fuller use of both manpower and natural resources and perhaps have a little less of the ivory tower approach so that a graduate in engineering and the allied sciences can respond quickly and successfully to local industries' problems.

We can only hope that the Auckland set of rules was made to protect the teaching staff from too heavy a burden. But how much better to say, "we will do your work, we are interested in your problems but did you know we had a problem, too—shortage of staff and money to do it."

The rich endowments of overseas universities have been the result of close contact with the individual or organisation—the endowment nearly always the payment of a debt of gratitude. Admittedly, our country is young and small and some Government changes would be needed in taxation and gift duty legislation but our business leaders are not so tough and hard that they would not repay help given—but **is** it being given at present?

— W.L.

ENQUIRY CARD AD. 18

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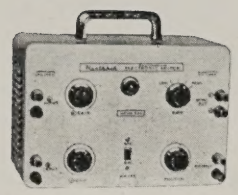

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ENQUIRY CARD AD. 19

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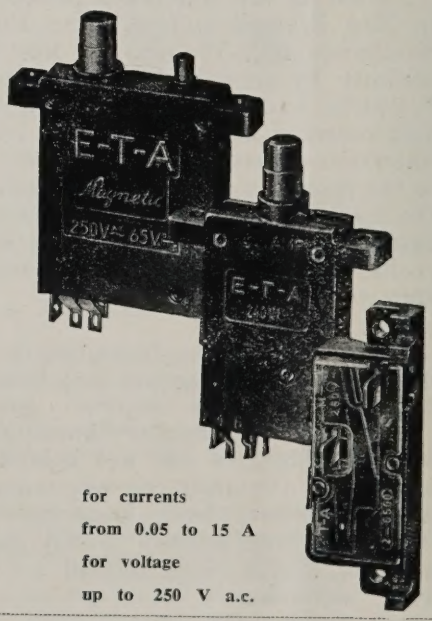

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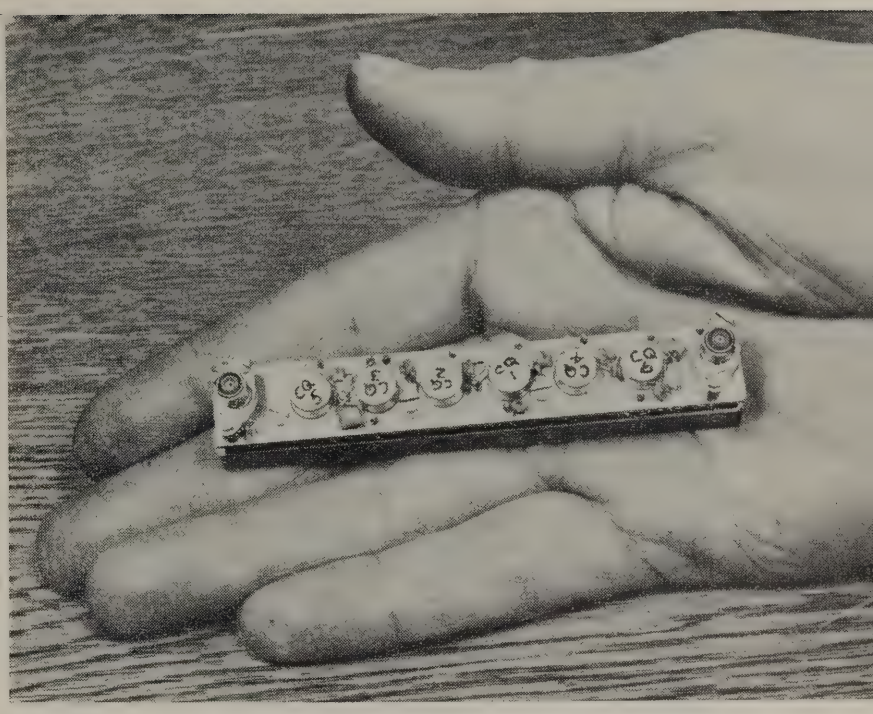
MICROELECTRONICS

The tiny shape of things to come

*by W. J. Baker**



Of all the many new techniques which are at this moment emerging from the research laboratories, none is potentially more dynamic in its impact than those grouped under the general title of "microelectronics". If its promise is fulfilled, microelectronics must surely revolutionize the whole of the electronics industry, sweeping away many conventional ideas about manufacture and creating in the process a new generation of engineers and technicians whose work will have little in common with those of the moment.

This is not to predict that existing techniques will go by the board overnight. On the contrary, the anticipated changeover may well be a gradual one, and in some areas of manufacture microelectronics may find the position unassailable. In these connections, the process is ill-served by the unfortunate choice of such expressions as "microelectronics" and "microminiaturization" which conjure up a mental image of very small equipments indeed, and thereby promote the idea that the techniques are only of interest to those whose chief concern is with small size and weight.

This concept, which appears to be widely held, is a complete fallacy. It is perfectly true that small size is a characteristic of "micromin" equipment, but this is only incidental; a bonus, as it were, which may be useful in certain instances. The real and overwhelming advantage lies in the inherent reliability, which is far superior to anything which can be provided by conventional equipment. It is this attribute which brings the application of microelectronics right out of the limited specialist fields and places it astride the entire electronics industry.

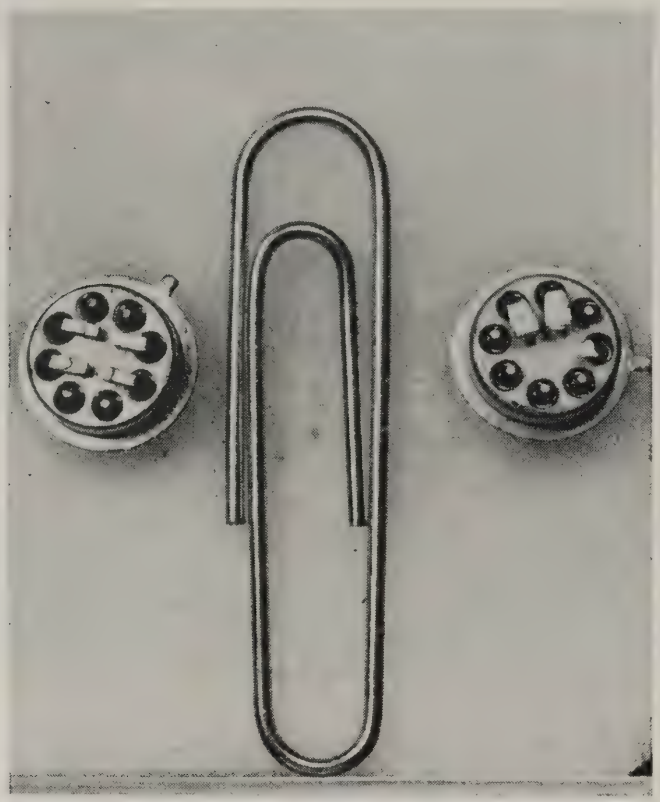
Although the processes are only newly-born from the laboratories the gestation period extends over the past twenty years, for it was during World War II that one of the two main approaches to the art, the thin film technique (or rather, a forerunner of it) was first tried experimentally for use in proximity fuses. The real breakthrough did not, however, come until after the invention of the transistor in 1948 which opened up entirely new avenues of approach, and the acceleration of research into guided weapon and space vehicle problems in the 1950's, which provided the urgent need. In this work, of course, the main attraction was in fact the small size and light weight and so the "microelectronic" label was appropriate at the time of its coining. It was only subsequently, when the tremendous advance in reliability was fully appreciated, that the term became something of an embarrassment, but by that time it was fully established and it is probably too late to do anything about it now.

Why is the reliability factor so important? For several reasons, one of which is that it is vital in all applications in which the equpment is inaccessible for servicing, as, for instance, in unmanned satellites. Another reason is a matter of economics; the longer an equipment keeps going, the smaller the maintenance staff required to look after it.

But over and above these is the demand for improved reliability brought about by the ever-increasing complexity of modern electronic equipment. As a simple illustration of this, consider for a moment an imaginary equipment having ten components in it, each of which has a known statistical degree of reliability, and each of which in breaking down causes the equipment to fail. Under such circumstances the periods of time which may be expected to elapse between failures can be computed with reasonable accuracy.

* The Marconi Company Ltd., Chelmsford, Essex, England.

Above: A 5 Mc/s i.f. amplifier showing the six encapsulated microcircuits.



Microcircuits mounted on TO-5 headers (about one-third of an inch in diameter). On the left is a header embodying the transistors and diodes which comprise a logic element of a computer. On the right is one stage of an i.f. amplifier (resistors and capacitors). The paper-clip, shown for size comparison, is standard office size.

Now, suppose that instead of ten components the number is increased to a hundred. At one stroke the reliability factor of the equipment is reduced to at least one-tenth of its original value; to take this to its logical conclusion, equipments could be evolved of such complexity that statistically they could not be expected to work at all, because at every instant of time one or other of the components is scheduled to break down.

Such an absurd situation, of course, only presently exists as a trend. But it is a trend which has to be reckoned with, particularly in view of the fact that the upper limit of reliability in the manufacture of conventional components is being reached. The only hope of salvation lies, therefore, in the evolution of some entirely new method of component manufacture which gives greatly improved reliability. Only in this way can the status quo in terms of reliability of the overall system be restored. Microelectronic techniques not only achieve this aim, but better it.

The reason for this spectacular jump in reliability lies not, as might be supposed, in some inherent molecular magic, but rather because of the drastic reduction in the number of manufacturing processes involved.

To see something of how this comes about it is necessary to visualize a given component—for example, a resistor—not as one is accustomed to do, namely as a pure resistance, but to see it as it really is, as a mechanically-bonded conglomeration of good and bad conductors mechanically joined to the rest of the circuit by a series of pressure or soldered contacts. Looked at in this light a resistor becomes a mass of contacts (good, bad and indifferent) throughout its physical structure and beyond to its points of juncture with the rest of the circuit. It is invariably at one of these contacts where breakdown occurs, particularly in the commonly-met circumstances when two dissimilar metals are joined.

Microelectronic techniques, by employing far fewer intermediate contacts in the manufacturing process, reduce the number of potential trouble-spots very substantially. Furthermore, unlike the majority of conventional components which are usually continually exposed to atmospheric contamination throughout their lifetimes, the microelectronic components, after fabrication, are encapsulated, after which the container or "header" is baked out at a high temperature, then filled with an inert gas and sealed. As a consequence of all this, the reliability graph streaks upward in a very healthy manner.

At the time of writing, there are two main approaches to micromin manufacture. One is known as the thin film technique and the other as the semiconductor integrated technique, and, needless to say, each has its protagonists and adversaries. The physical means of manufacture of these is already well-documented and therefore has no place in a general discussion such as this, so no more than an outline is given here:—

The thin film technique uses an insulating base, such as a ceramic, upon which is deposited appropriate layers of conducting, resistive and insulating materials so as to form interconnections, resistances and capacitors. Various means of doing this exist, including the preparation of a mask, through the apertures of which the materials are introduced, or by vacuum deposition methods. The former method in particular permits considerable flexibility in the laying down of passive components (resistors and capacitors) and even complex circuits utilizing these can be produced quite cheaply and with excellent reliability. Active components (transistors and diodes) cannot however form an integral part of the structure and these have to be made separately and attached to the passive components by connectors. As such means are to be avoided as far as possible, thin film techniques are of most value in circuits

where passive components predominate.

The semiconductor integrated method is, on paper, by far the more elegant as, in an ideal case, such a circuit would consist merely of a small block or chip of semiconductor having input and output terminals and performing the same function as a conventional circuit, but without having any identifiable components within itself. To those who may find difficulty in visualizing such a device, it may be mentioned that a quartz crystal oscillator affords a near-parallel, for here we have a tuned circuit which possesses no identifiable areas of inductance and capacitance by which resonance is achieved.

It must be hastily added that this idealized semiconductor unit is at present no more than a design concept, and may well remain a pipedream. The best that can be done so far is to form a complete circuit within the semiconductor chip, but one in which the individual component areas are discernible.

Even this has its limitations, however. So far, silicon has proved to be one of the best semiconductors for the purpose and is certainly the most widely used, but even in silicon you cannot, for instance, form anything but small capacitors (at present a maximum of about 100pf) without taking up an excessive amount of the overall area of the chip.

Again, although large numbers of active components can be produced in a single chip by diffusing suitable impurities into selected areas, the insulation between components (formed by back-biased p-n junctions) is not good. This factor is responsible for such undesirable effects as the production of "phantom" components in even the simplest of circuits, and as a result, the equivalent circuit is quite a complex combination of resistances, capacitances and active components, and not at all what the designer intended.

To add to his problems, it is not possible to produce, in the present state of the art, semiconductor integrated resistors to a tolerance better than ±20%, although this is mitigated to some extent by the fact that all resistors within a given chip will depart from their desired values by the same percentage amount. In practice, therefore, it is necessary to manufacture a number of circuits and then select the chip which conforms to specification—a process which makes for low yields and high costs.

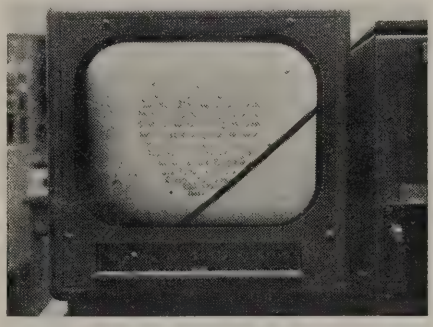
In view of these and other rather depressing disadvantages it might seem that the thin film microcircuit, in which close tolerances, good inter-component insulation and a much closer agreement between the desired and equivalent circuit realizations is possible, would lead the field. This is by no means the case, however. Semiconductor integrated devices come into their own when the ratio of active to passive components is high, and many of the limitations can be bypassed by designing around them. Furthermore by abandoning the concept of putting all the components on a single chip, except for the simplest of circuits, and instead, manufacturing all the resistors on one chip, capacitors on another and diodes and transistors on another (or alternatively arranging them in standard groupings) for subsequent interconnection within a single envelope, a much more flexible system evolves and complex circuits can be produced.

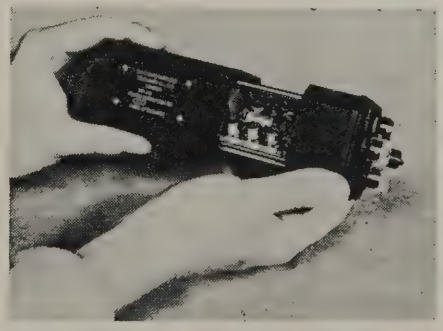
The multi-chip approach, in fact, brightens the horizon very considerably. Diffused resistors, silicon dioxide capacitors, n.p.n. or p.n.p. planar transistors, planar diodes and zener diodes no longer have to be produced in one material; instead, each type can be manufactured in the most suitable semiconductor for the particular purpose. Isolation between components is very much improved—a factor which permits its usage for high frequency work. Such advantages, on balance, outweigh the disadvantage of having to provide inter-chip connections, and although admittedly a compromise it is a very successful one in practice.

Another variant is possible by manufacturing the transistor-diode elements in a semiconductor slice and then adding thin film capacitors and resistors by deposition. This hybrid method has much to be said for it as it combines the best features of both thin film and semiconductor integrated techniques; it can of course be equally applicable to single and multi-chip manufacture.

It was said at the start of this article that microelectronic techniques are likely to revolutionize electronics manufacture. This will undoubtedly come to pass, although the transition will probably be gradual, and conventional components are unlikely to disappear wholly, unless really sensational further advances are made, notably in the matter of power-handling capacity.

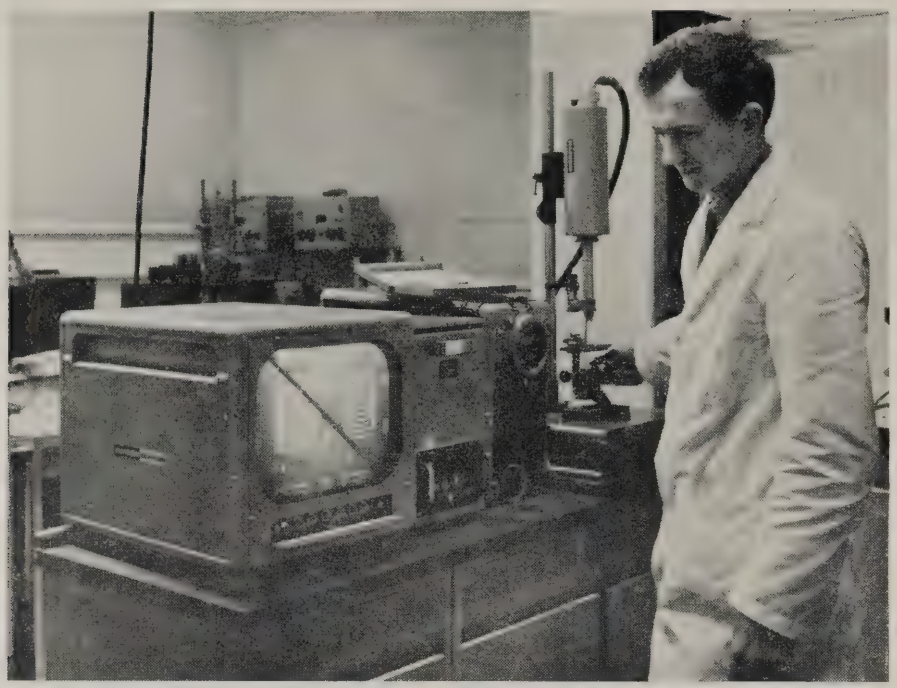
Beyond dispute, however, the advance of microelectronics into the mass manufacturing stage





Left: The Lord's Prayer shown on the monitor screen was first typewritten then photographically reduced and finally transferred photolithographically and etched into silicon oxide on a silicon wafer the size of a pinhead (this is the general procedure for the production of silicon devices). The result, enlarged by a closed circuit television system, is seen on the monitor screen. The slantwize "bar" is a human hair.

Right: An experimental 75 Mc/s Marker Beacon receiver for aircraft. Microminiaturization has reduced the size to one-quarter of that of the standard receiver and considerably increased the reliability factor.



5 watt 100 Mc/s silicon planar epitaxial power transistors shown on the closed circuit monitor screen, with a human hair providing a size reference.

will, sooner or later, uproot conventions which are as old as the industry itself. It is, for instance, common practice for the equipment manufacturer to buy in many of his component needs, such as resistors and capacitors, from specialist manufacturers of these items, a procedure which has held good through the miniature and sub-miniature phases which have evolved in certain areas of manufacture over the past twenty-five years or more. Now comes microminiaturization, in which the components and interconnections are formed in a simultaneous process on perhaps a single speck of semiconductor, and, ipso facto, the component manufacturer and the circuit manufacturer are no longer discrete entities. On which side of the fence will the work be done then?

Let us assume for a moment that it is the former. In this event his role will be quite different from his present one, for he will no longer be turning out discrete resistors or capacitors for incorporation into the system manufacturers' equipment; instead he will be producing whole circuits, which, to the systems man will amount to a black box which will produce a stated output from a given input. What is in the black box will be none of the systems man's business.

Such a situation, needless to say, is not likely to be at all acceptable to the systems manufacturer, and particularly to the designs groups, who have always been accustomed to have the say in what the ultimate customer is getting, both in terms of components and circuits. At the very least the situation will call for the closest possible liaison between the two groups.

On the other hand, will the systems manufacturer set up his own plant to produce his microcircuits? Whichever way it goes, a lot of capital outlay will be involved, with a call for an entirely new category of employee, and the conventional pair of pliers exchanged for the tools of photolithography and the physicist.

But there is even more to it than this, for the changeover is not merely a matter of taking a conventional circuit and microminiaturizing it. Between the blueprint of discrete components and the production of micromin masks lies an essential stage of transition which can be very intricate, calling for special skills from those responsible.

As a case in point, the astute reader will already have noticed that whilst transistors, diodes, resistors and capacitors have been discussed, no mention has been made of inductors. This is for the simple reason that in the present state of the art, no means of producing an actual inductor in micromin form has been evolved, and probably never will be. Much more likely is the achievement of the simulation of inductive effects as instanced earlier by the quartz crystal.

So, with no inductor available, the designer, whenever he meets with one in the conventional circuit, has to try to find a way around it, and usually he can. Intermediate frequency transformers or audio power output transformers can be replaced, for example, with equivalent resistance-capacity networks.

This necessity to design an equivalent circuit is met, not only in the matter of inductors but in many other parts of a given exercise. Various technical tricks can be used to solve many temperature stabilization and heat distribution problems; unduly large capacitor values can often be reduced by careful redesign, but these and other stratagems, whilst perfectly legitimate, can (and almost invariably do) add up to a circuit which, in detail, is quite unlike the original conventional one.

Electronic circuitry falls, broadly speaking, into one of two categories, digital and linear. At the expense of some scientific accuracy, digital circuits may be described as essentially switching devices whilst linear circuits are those in which there is a definite (but possibly at first glance, tenuous) relationship between input and output.

Digital circuits are basically simple, although the equipment of which it forms a part may be complex, but this is usually by virtue of employing a considerable repetition of the simple circuit. Digital computers are a typical example.

Linear circuits on the other hand are usually required to handle complex signals and such

— Continued on page 37

R. E. & C. Experimenters 5" Tv Receiver

by Irving Spackman

Ever since the inception of TV transmissions in this country we have received demands for details of a simple TV receiver utilising the more commonly found 5 and 6 inch electrostatically deflected cathode Ray Tubes.

Large numbers of several kinds of these tubes found their way into the hands of experimenters after the war as "War Surplus" and many of those same tubes are still residing on shelves waiting to be put to good use.

The type of set to be described in this and following articles is ideal for people who would like some practical experience with constructing a TV receiver but who do not wish to devote a large financial outlay to the project. Some may even own a commercially manufactured receiver, but for obvious reasons they do not wish to commence taking it apart to see what makes it tick.

The design of the receiver is quite basic, and devoid of any frills. Major portions of this receiver can be used at a later date should a fully grown set using a 19 or 23 inch tube be considered. This brings up the subject of the picture tube itself.

Many people have asked "Are these surplus tubes any good for television use?" "Does a 6 inch tube give a large enough picture?" "Can a green screen be used?" To answer these questions is quite simple. To all the questions the answer is "Yes". A VCR97 will give a picture which can be easily viewed by four people, even in daylight if direct light is kept from falling on the face of the tube. By slightly over-scanning the tube so that the picture fills the tube face the image is considerably larger than first expected, providing the viewers do not sit too far away. The green screen referred to, of course is the phosphor colour. As a matter of fact the sensitivity of the eye in the green region is at its best, and consequently the contrast between light and dark regions of the picture is very good. Good brilliance requires plenty of high voltage on the tube and good contrast demands adequate video voltage. Both of these are adequately provided in this design.

Let us now consider the receiver itself. As can be seen in the block diagram, the receiver is divided basically into three sections. The first of these is the RF, IF, Sound and Video Section. The second part discusses the control and deflection of the electron beam in the picture tube; whilst the third part covers the picture tube and all the necessary voltages to operate it. As can be seen from the block diagram in Part 1, we have a Tuner, and I.F. strip for the composite vision and sound signals, a detector system with associated A.V.C., a sound I.F. and detector, a video output amplifier and a sound output amplifier. Also shown on the circuit for this part is the main power supply for the receiver itself, which will be necessary when testing time arrives.

Now we will discuss each part of the first section in more detail.

The Tuner: It is recommended that a tuner be purchased, particularly if a full-size receiver is being considered at a later date. However, in the last part of the series, we will describe a single channel tuner for those who for one reason or another don't wish to go to the expense of the conventional tuner.

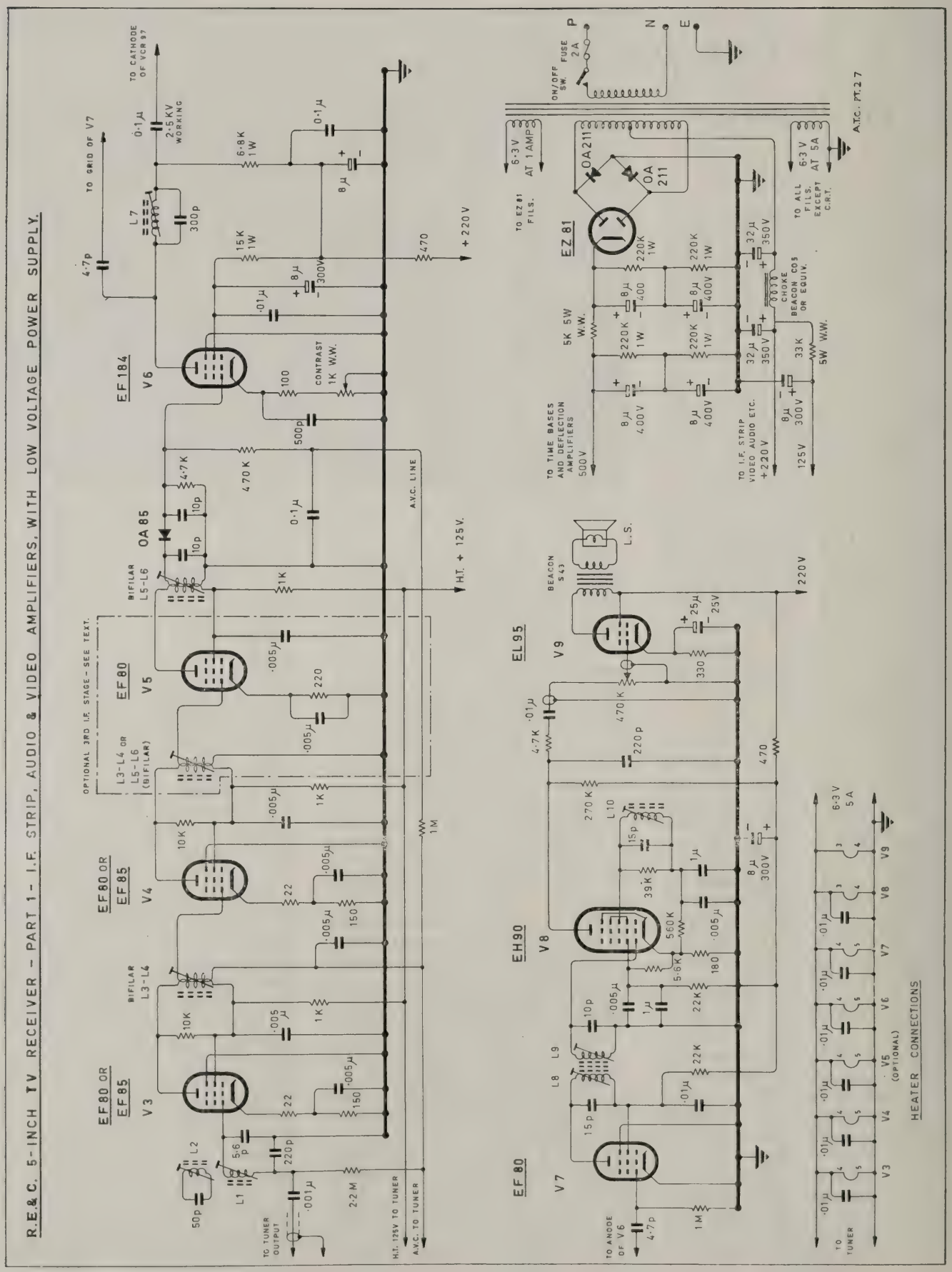
The I.F. Strip: The I.F. strip itself consists of two basic parts. The first of these is the high frequency composite I.F. chain centred on approximately 35 megacycles. This passes both the vision and sound carriers and the picture information which lies between them. After detection, the sound I.F. channel accepts the "intercarrier" beat of 5.5 megacycles which is produced in the vision detector, amplifies it and then "detects" it in the sound detector. The sound frequency of 5.5 megacycles is "frequency modulated" so that the sound detector must respond to variations of frequency rather than variations of amplitude.

(See "Looking at F.M. Detectors," R. & E., June 1963).

The Vision or Video Amplifier: This stage amplifies the signals which have been detected by the vision detector. This "amplifier" is considered a "wide band" amplifier in that it must amplify without distortion, signals of frequency extending from a few cycles a second (actually D.C. is really required) up to at least 5 megacycles per second. In point of fact, the video amplifier in this receiver is used to provide some amplification also for the sound I.F. frequency of 5.5 megacycles. This is trapped off the output of the video amplifier as it must not be fed into the picture tube, otherwise serious picture distortion would occur. The video amplifier must also provide sufficient voltage to control the electron beam in the picture tube.

The Sound or Audio Amplifier: This is purely used to amplify the signals from the sound detector to such a level that they will actuate a loudspeaker.

Having now discussed the functions of the various sections, we will now return to the circuit part of the receiver. The design and construction of this will probably be the most time consuming, as there are a number of coils to be wound. Depending on the locality in which the receiver is to be used, and thereby the field strength available, the I.F. strip will use either two, three, or four stages. Under most conditions, two or three stages will be quite adequate, while the four stages would only be required if the location was in the "deep fringe" area of a main station, or operating from a low power translator on one of the higher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TO ANODE OF V6
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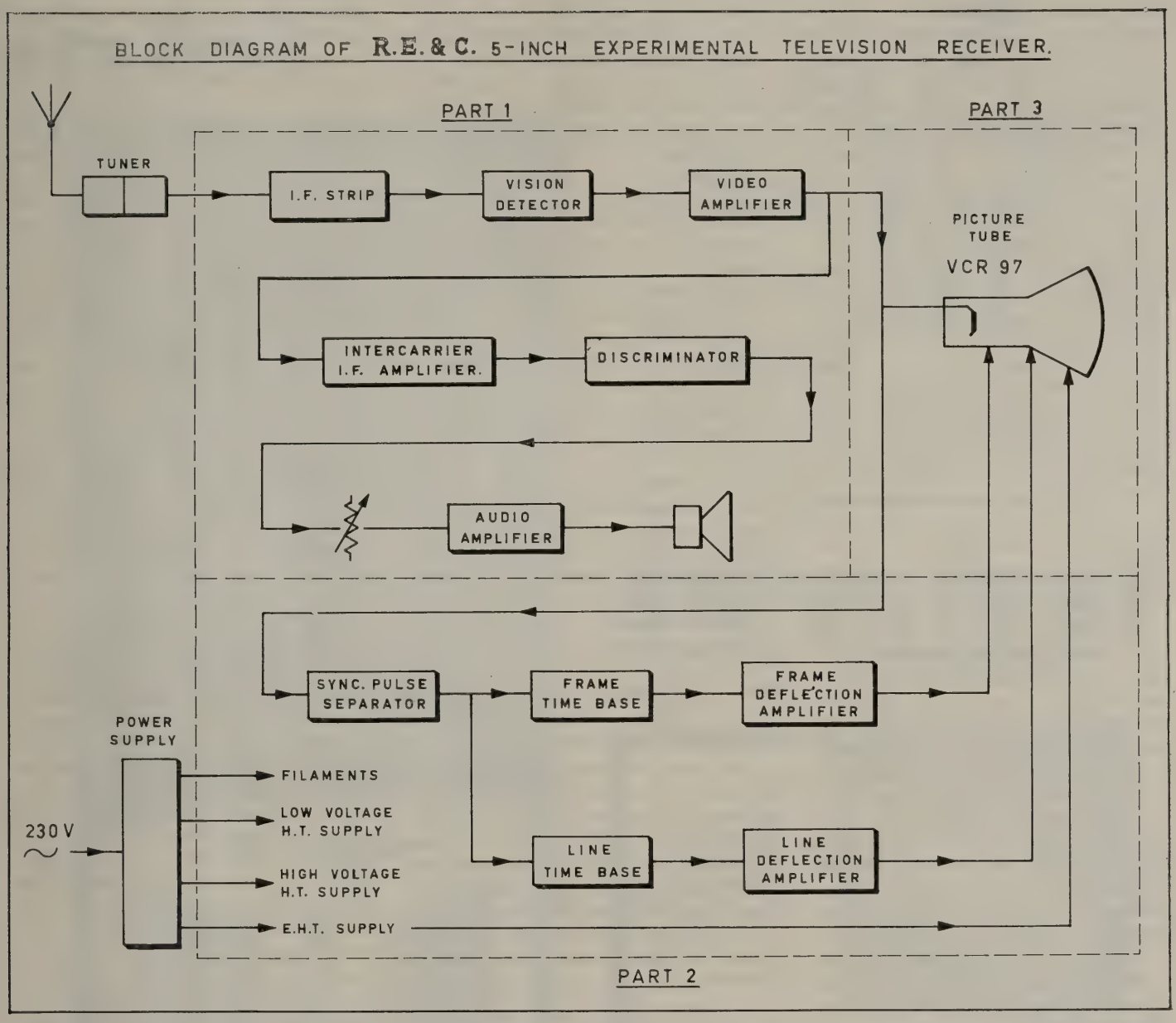

frequency channels. In any case, correct alignment will produce the band pass characteristic for best reproduction.

Basic Construction Considerations

The first point to be considered in constructing this receiver is the method of chassis layout. This will determine a number of factors which will be involved in later discussions. One suggestion is to consider the use of a full size TV receiver chassis, with all the receiver sections mounted on it. If large cut-out areas are used where separate sub-chassis can be attached, then this method has much to recommend it. However, such chassis are quite expensive, and are not always readily obtainable, and if obtainable do not necessarily provide the correct location for the parts of the circuit we are describing here. As far as the author's equipment is concerned, the receiver is constructed on three separate chassis. The first of these contains all that is shown under the circuit diagram for part 1, with the exception of the power supply. The second chassis accommodates the picture tube and associated deflection circuits, which are covered in parts 3 and 2 respectively, whilst the third chassis carries the power supplies. The individual chassis are easily handled during construction and later during experimental modifications, but all three are easily secured to a simple half-inch wooden baseboard which serves to hold all the respective units in relation to one another. Under no condition should the chosen chassis make for crowded conditions or layout. As long as all the major component leads are of the correct length, there is little to be gained in making the equipment very compact. Where possible standard types of chassis have been utilised and these are readily available through the normal radio parts outlets. Another point to be remembered is that many home constructors have run into trouble by having unwanted interaction between various circuits, particularly in the line and frame timebase sections.

The Vision I.F. Strip

This section of the receiver will undoubtedly require the greatest attention to detail. The construction of the I.F. strip necessitates the winding of a number of coils; and the assembly and wiring of a section of the receiver which, if incorrectly carried out, will result in a poorly performing receiver. Do not hurry the construction of this section. If, however, the construction and alignment is carried out in a conscientious fashion then it will provide picture quality as good as any commercially constructed I.F. strip operating into an equivalent type of picture tube.

Recommended I.F. Frequencies

The frequencies recommended for television receiver I.F. channels are as follows:

I.F. sound frequency 33.4 mc/s, I.F. vision frequency 38.9 mc/s.

This means that the I.F. strip must pass the frequencies listed above, and, in addition, must also pass all the frequencies lying between them, so that the necessary video information can be passed on to the respective circuits in the remainder of the receiver. For the best performance it is also necessary that the I.F. strip does not respond to signals falling higher and lower than the I.F. channel which may have passed through the tuner. In particular, these signals could come from other TV stations operating in the channels adjacent to the one being received.

For the best sound reproduction, it is necessary that the sound carrier be partly attenuated during its passage through the I.F. strip so that the ratio of vision carrier to sound carrier is optimum when detection takes place, and the inter-carrier beat is produced which is again amplified as the sound I.F. frequency of 5.5 mc/s (38.9 − 33.4 = 5.5 mc/s).

General Considerations of the I.F. Strip

From the aspects of construction and alignment, the simplest type of wide band amplifier is the design with single tuned coils, stagger tuned to various frequencies. This means we build a multi-stage amplifier in which every valve is preceeded by a single tuned circuit. Each of these tuned circuits is adjusted to a different frequency and has a specific operating bandwidth determined by its inductance, and any capacitance and resistance placed across it. When the frequencies and bandwidths of the individual circuits are adjusted properly, the whole amplifier will have a frequency response that is flat inside the frequency range of interest; and by the use of several tuned circuits, the selectivity and thus the signal rejection ability of the amplifier will be good outside the desired frequency range.

In deciding upon the use of such a design a number of factors were considered. In the first place, all the coils can easily be made by the constructor, since none of them have very many turns. Secondly, when the amplifier is built, it can be aligned with a signal generator covering the appropriate range, and a meter capable of measuring the voltage at the detector diode.

The use of a sweep and marker generator or "wobbulator" and an oscilloscope will give the best alignment results in the shortest time, but a very presentable pass-band shape can be produced using the spot frequency and hand sweeping method which will be described in the next part of this article.

At this stage those who will have glanced at the circuit diagram for the I.F. strip will be thinking that there is an error. The circuit appears to show each of the coils as a double winding, between each valve, whilst a little earlier we mentioned single tuned circuits. Also, in some cases, there does not appear to be any tuning capacitance across the coils, whereas in other cases there are. The double winding is, of course, a "bi-filar" or unity coupled transformer. The two windings are, in fact, two wires, wound side by side, thus ensuring very tight coupling between the two windings, so that for the purposes of tuning, they can be considered as a single winding. The reason for using the "bi-filar" winding rather than a single one with resistance-capacitance coupling to the next stage is that it enables each part of the winding to be kept completely isolated, and only associated with the valve to which it is connected. This enables more stable and reliable electrical performance to be achieved for little extra effort. Now the next question comes up — that of the absence of tuning capacities. In any broad-band amplifier, the maximum bandwidth is always obtained by using tuned circuits with the highest possible ratio of inductance to capacity. In this case there are some "invisible" capacitances present in the form of "strays" and the interelectrode capacitances of the valves and associated sockets. The tuning of the circuit is by means of adjustable inductance, and this is effected by means of the introduction of a tuning "slug" made of special magnetic material.

Where capacitances are shown, these are required where there are no tubes present, and therefore their capacitance is absent, or where there are other design considerations. The first stage in the I.F. strip is basically a "pi-coupled stage," by means of which the low impedance coaxial cable carrying the signals from the tuner is matched into the high impedance grid circuit of the first valve.

There is one other coil in the vision I.F. strip which we have not mentioned yet. This is L2, and, tuned by a 50 pf. capacitor, is used to shape the I.F. response curve at the sound carrier end. There is considerably less turns and more capacitance used in this case to provide a much higher "Q" tuned circuit as the frequency to which it is tuned is quite specific—it is definitely not a wide-band device.

The reader will also notice that resistors have been placed across the primary of two of the coils, both numbered L3, L4. This resistor is included to damp the tuned circuits. Even without any tuning capacity, the bandwidth of these coils without the damping resistance is insufficient, so the resistance is included to lower

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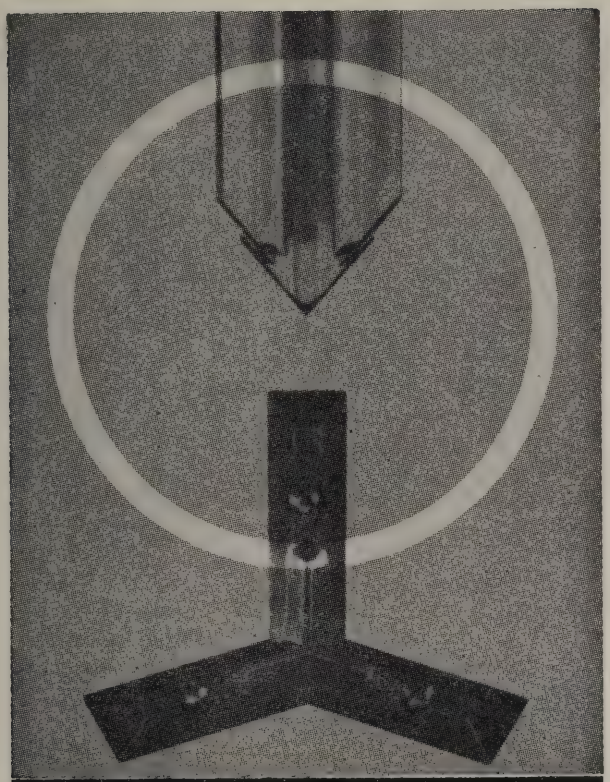

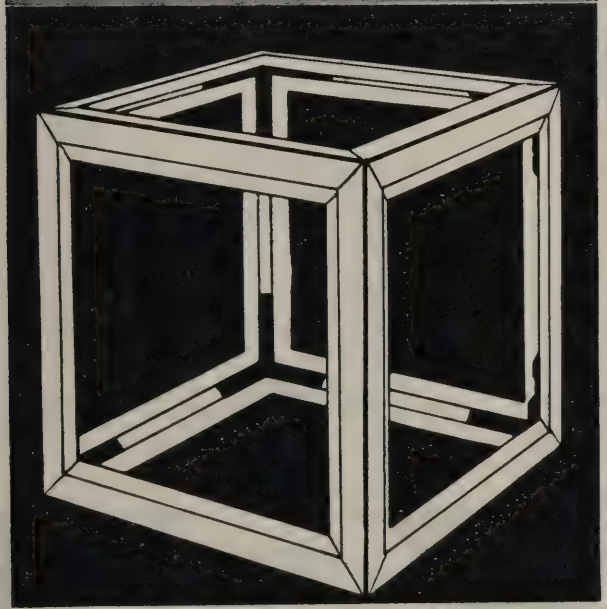

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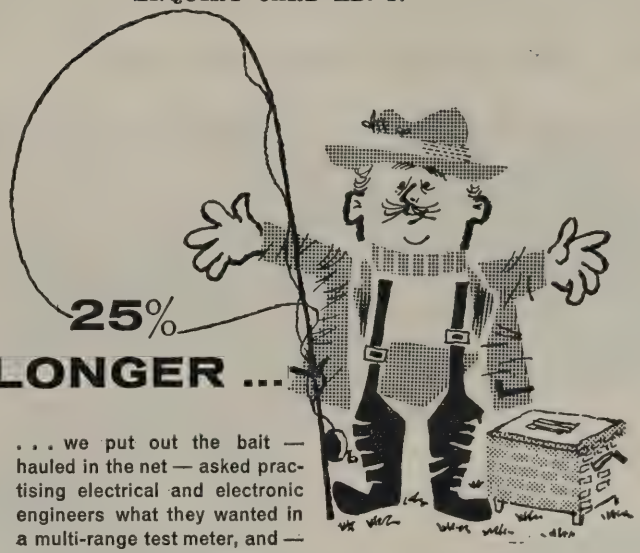

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Crystal Radio Set

Coming on to the market in time for Christmas shopping is a crystal kit-set from Philips Electrical Industries Ltd. Intended for the younger members of the family, it could safely be assembled by a 10 or 11 year old in a few minutes.

The kit-set comprises aerial coil, tuning capacitor, diode and load resistor with the simple chassis, connectors and earpiece. No solder connections are required as all connections are made to fanstock clips. The only additional material required that is not part of the kit is the aerial and earth wire.

Assembly took this reviewer 15 minutes but a child would probably take a little longer. The instructions provided are clear and well illustrated and a non-technical mum or dad could certainly help out but we feel it would be a dull Jack that could not tackle this simple kit-set.

Performance? Well, to one accustomed to 8 transistors and 16-valve stereos it was a welcome change to listen to all that was being radiated from 1YA. A young friend reported, "You must have a super aerial on the end of that." Yes, indeed; 20 feet indoors plus a good earth. The same young man reports good reception at Rotorua, a notoriously bad area for reception.

The kit-set is completed by a stout cardboard "cabinet" but we feel most youngsters will leave it open to "see the works." Provision is made for tapping the aerial coil, also. It will retail at around the 40/- mark and it will be a welcome antidote to TV at that price.

— C.W.S.

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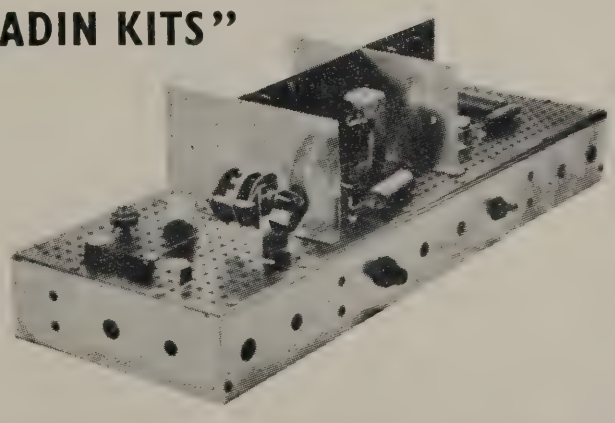

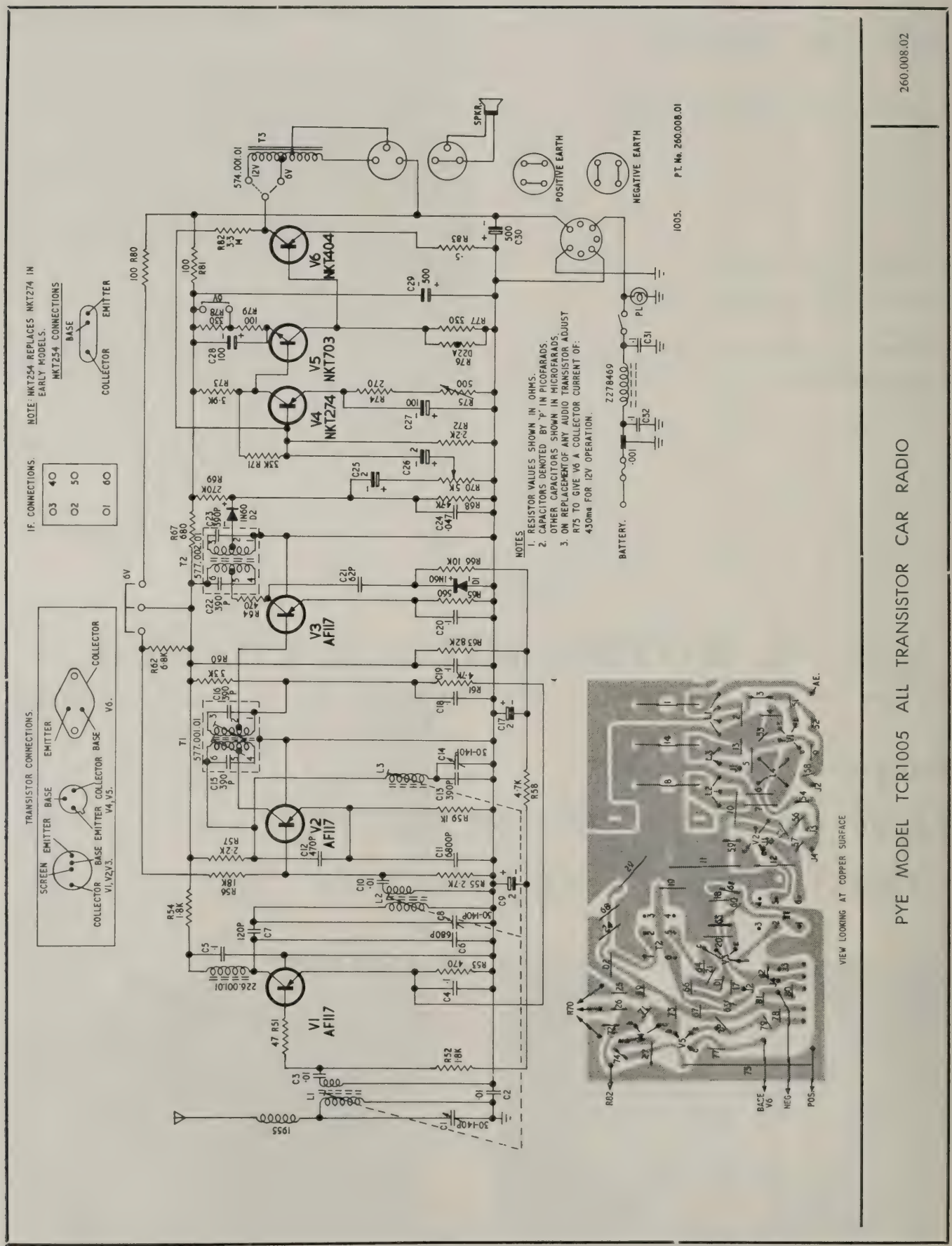
PYE MODEL TCR1005 ALL TRANSISTOR CAR RADIO
260.008.02
NOTES
1. RESISTOR VALUES SHOWN IN OHMS.
2. CAPACITORS DENOTED BY 'P' IN PICOFARADS.
OTHER CAPACITORS SHOWN IN MICROFARADS.
3. ON REPLACEMENT OF ANY AUDIO TRANSISTOR ADJUST R75 TO GIVE V6 A COLLECTOR CURRENT OF: 430ma FOR 12V OPERATION.
NOTE NKT254 REPLACES NKT274 IN EARLY MODELS.
NKT254 CONNECTIONS
IF. CONNECTIONS.
TRANSISTOR CONNECTIONS.
VIEW LOOKING AT COPPER SURFACE
POSITIVE EARTH
NEGATIVE EARTH
BATTERY.
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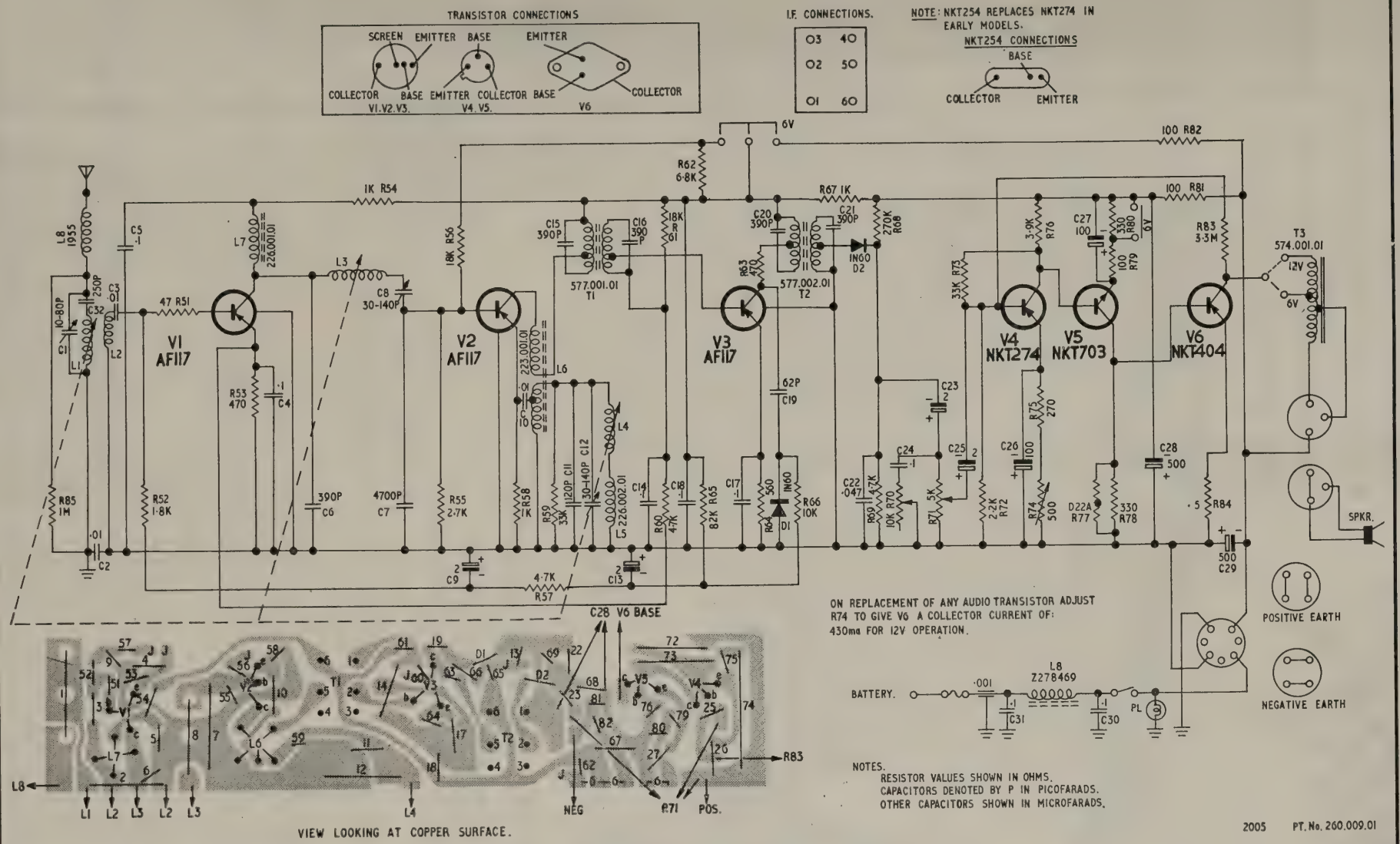
V1 AF117
V2 AF117
V3 AF117
V4 NKT274
V5 NKT703
V6 NKT404



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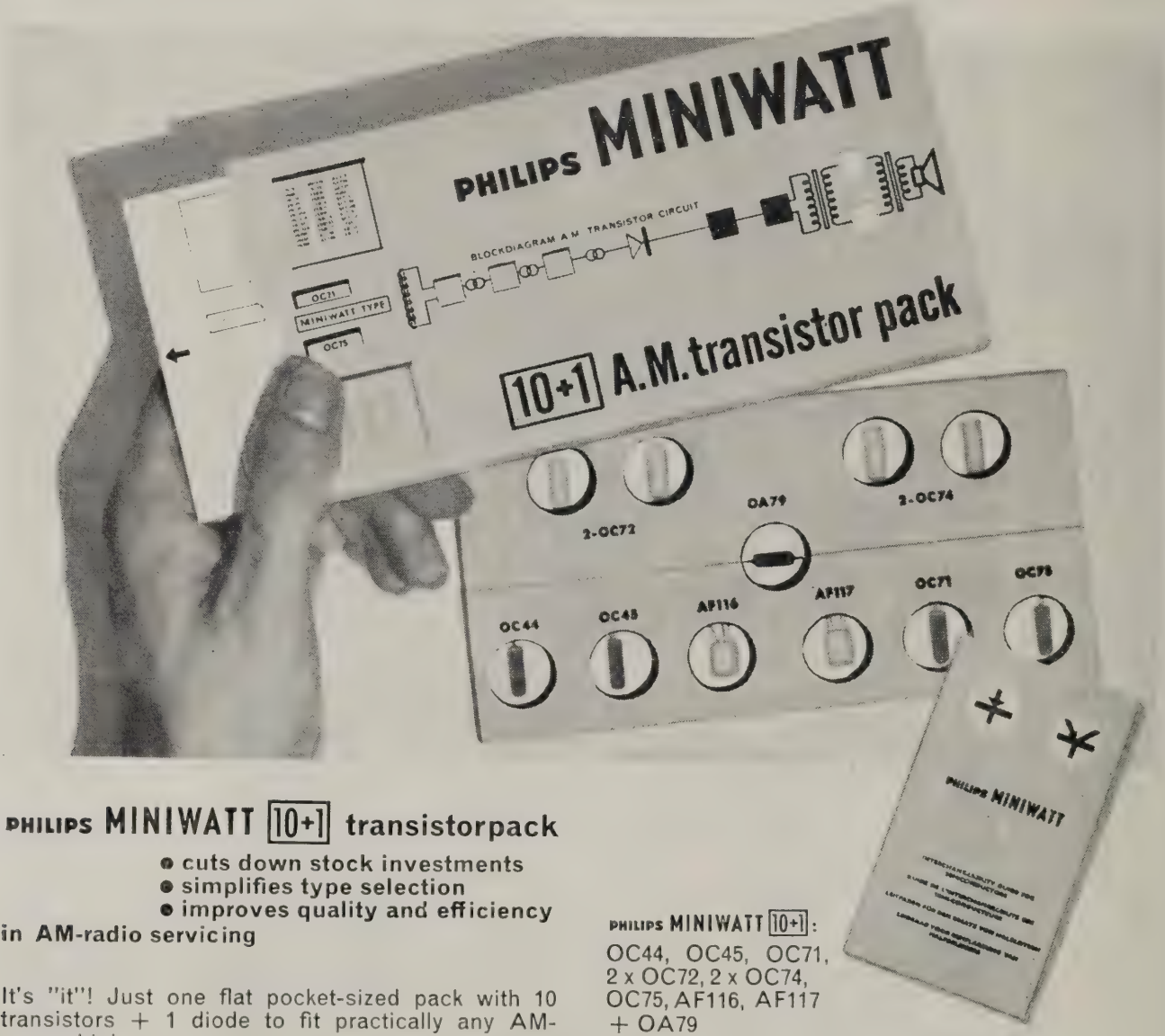

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SERVICEMAN'S COLUMN

Conducted by J. Whitley Stokes

One aspect of servicing which has always been of interest to me concerns the matter of alteration to original design in the course of carrying out service work. It has been repeated often enough that the serviceman's task consists solely in restoring a piece of defective equipment to original operating condition, and in general there can be no quarrel with this statement. It is only when one of two situations occurs that this rule need be departed from. The first is when due to the age of the equipment, or for any other reason, the non-availability of spare parts makes the use of substitute replacement parts necessary. The second reason is when for some cause or other the equipment as designed does not perform satisfactorily. Manufacturers, like servicemen, are only human so it does happen that they sometimes "make a blue." This may take the form of using a component which is inadequate or over-running a valve to name but two possible causes for unsatisfactory operation or over-frequent calls for service. It sometimes seems that the valve designer and the equipment designer are quite out of contact with each other even when they are both in the one organisation. I have on more than one occasion wondered whether the TV receiver manufacturer ever takes any notice of the valve maker's recommended valve operating conditions when designing a receiver. For example the recommended maximum grid resistor for a type EL36 valve is given as 500KΩ's yet how often do we find 2 or even 3 megohms being used? In such cases I have the feeling that it may be due more to good luck than good management that the line output valve does not fail prematurely.

That such apparent disregard of the valve maker's recommendations is not new is evidenced by this example from the past.

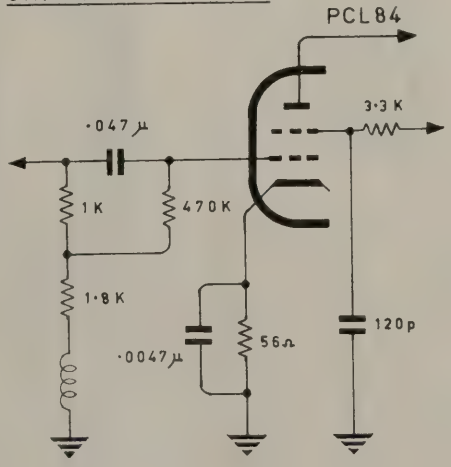
One local radio manufacturer with an otherwise unblemished reputation had persisted in over-running the oscillator section of the 2A7 converter valve in several models. This over-running took the form of feeding the oscillator plate direct from the B+250v line instead of through a 20K resistor as stipulated by the valve makers. The result of this error was that the plate dissipation of the oscillator section was increased to the point where the oscillator plate electrode could be seen glowing red hot! Hardly conducive to long valve life one would imagine yet in spite of this abuse the valves stood up remarkably well. However, I was never very happy over this particular "design" and always added the 20K resistor and a suitable bypass condenser. That I was not the only serviceman with such ideas was shown by the fact that I frequently came across other cases where a former serviceman had carried out the same modification "on his own bat." A sidelight on this particular little story is that due to the fact that the products of this particular manufacturer were held in such high regard, many smaller manufacturers copied both the circuitry and the construction. So the same error was built into their products too! It couldn't happen nowadays or could it?

See what you think of this anyway. I had been having a bit of bother with the video output valves (type PCL84) in one model TV receiver of well known make. This trouble took the form of unreliable sync and gradual alteration to the brightness level after the set had been running for about half an hour. In each case the symptoms were the same, a low plate voltage on the valve with a positive voltage on the grid. It was found when starting off from cold that these voltages were normal and the set operated correctly. From this it seemed likely that there was either some leakage of positive voltage to the grid or that the valve itself was gassy or suffering from grid emission. In some cases a new valve would improve matters for a time but after a while the same symptoms would occur. As no other cause such as leaky condenser could be found to account for the trouble I began to wonder whether the valve operating conditions were all that could be desired. This idea was given weight by the fact that earlier models from the same manufacturer had not exhibited similar symptoms and I had not come across this trouble in receivers made by other manufacturers. An examination of the circuit immediately showed three unusual aspects in the design of the video output stage — these were as follows:

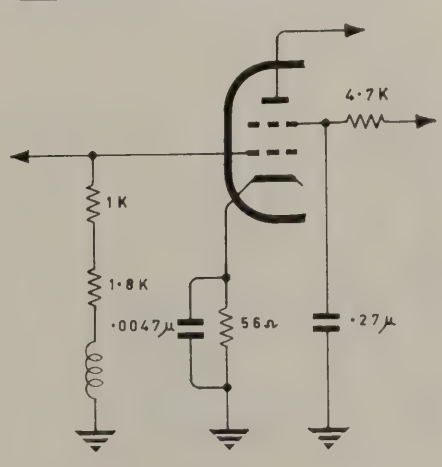
1. The grid was not directly coupled to the video detector diode load but was "tapped down" half way and coupled through a .047uF condenser. A

—Continued on page 40

ORIGINAL CIRCUIT



MODIFIED CIRCUIT



MAGNETIC TAPE DATA RECORDING

Part 1

*by P. L. Watts**

Magnetic tape recorders have become increasingly important over the past few years, not only in the various acoustic and measurement fields, but more particularly for storing and processing large quantities of scientific and business data. Fundamentally, the tape recorder can record any electrical signal and any phenomena which can be converted to or represented by an electrical signal.

There are two basic reasons for the increasing use made of magnetic tape in data recording.

Firstly, magnetic tape is the only reasonable means of gathering large quantities of data at very high speeds over either long or short periods of time. The very mechanical nature of the magnetic tape recorder permits a variable time base and events may be reproduced at either faster or slower playback times. This means that data gathered over, say, one hour may be reproduced, and even re-recorded, in just a few minutes for possible subsequent processing by a computer.

Secondly, the actual recording capability provides accuracy over a wide frequency range together with high density storage on a minimum length of tape.

The first part of this article reviews the basic theory of magnetic tape recording and considers techniques of analogue recording in the "Direct Mode."

As the history and basic fundamentals of magnetic tape recording were fully discussed in the April 1961 and May 1961 issues of Radio and Electrical Review in Mr. G. B. Goodall's series on videotape recorders, the following serves in part as a review.

Principals of Recording

The tape recorder consists of three basic parts, firstly the encoding and decoding devices, which in a domestic recorder would correspond to a microphone plus record amplifier and playback amplifier plus speaker. The second part is the magnetic head assembly which consists of a record head, simply a coil of wire wound around a magnetically "soft" core, to convert the electrical into a varying magnetic state on the tape; and the "playback" head, simply a transducer to reconvert the magnetization on the tape into electrical output signals. The third part is known as the tape transport and moves the tape across the magnetic head assembly at a constant linear speed.

There are several different recording processes which will be discussed, however they fundamentally only differ in the encoding and decoding methods. These processes can be divided into two categories: analogue and digital recording. Analogue recording is where the input signal is represented on the magnetic tape by an electrical analogue. Digital recording is where the data has been converted into pulses whose position in time, presence or absence, amplitude, duration or polarity represent discrete data values at a certain point in time.

Direct Recording

The technique known as direct recording is well known to high fidelity enthusiasts in its basic form, although often mistakenly referred to as A.M. recording. Direct recording is classified under the heading of Analogue Recording.

In direct recording, an input signal voltage is converted to a proportional current which is then used to drive the record head. Figure 1 shows the recording head consisting of a magnetically "soft" core in the form of a closed ring having a short magnetic gap in series with the magnetic path of the core. The tape travels over the gap in the core and is therefore influenced by the flux developed from the input current to the coil. As a consequence, the orientation of the magnetic oxide particles on the tape is related to the flux, and hence the input. This permanent magnetic orientation comes about at the instant the particle passes out of the gap, thus the

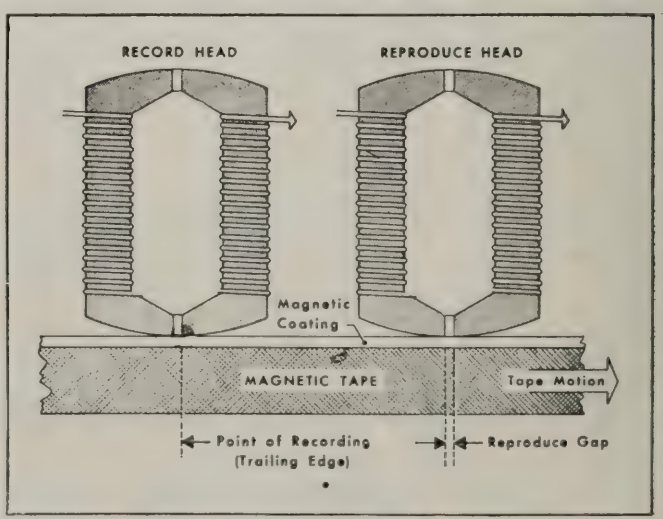


Fig. 1—The action of the record and reproduce heads is different. The recording is done at the trailing edge of the record head gap, while the gap on the reproduce head spans the signal.

* Sample Electronics (N.Z.) Ltd.

actual recording takes place at the trailing edge of the record gap.

Unfortunately, magnetic tape particles exhibit an hysteresis effect which produces a non-linear output for both large (saturated) and small inputs. The small-hysteresis effects may be overcome by simply superimposing a D.C. bias on the input signal to offset the tape magnetization to the more linear portion of the tape characteristics. However this only applies to one side of the hysteresis curve and excessive non-linearities still exist.

In amplifier work it is well known that, where push-pull techniques are used, even-harmonic distortion can be held to a minimum. Borrowing upon this scheme, it has been found that by mixing or superimposing a high frequency bias current instead of D.C. bias, both sides of the hysteresis curve can be used in their linear regions and even-harmonic distortion can be kept to a minimum. This effect is illustrated in figure 2. Although the amplitude of the high frequency bias signal is many times greater than the recording signal there is no A.M. process generating new sum and difference frequencies since the wavelength of the bias is made high enough to be too small to be resolved by the playback head. This will be more clearly seen in the following discussion of the "gap effect" under Reproduce Characteristics.

Figure 3 (a) shows the record head characteristic, and here the wavelength of the recorded signal is directly proportional to the tape velocity and inversely proportional to the frequency of the input signal. The wavelength of one cycle on the tape (λ) is related to the tape velocity by the formula:

$$v = f \lambda \quad (1)$$

Thus, as the tape velocity is increased at a given frequency, the wavelength is also increased.

Reproduce Characteristics

For "playback," the magnetic tape passes the gap of a reproduce head described earlier as a simple transducer. The reproduce head can be considered to be similar in construction to the record head. As the tape, with its changing magnetic field, moves across the gap it bridges the magnetic core of the reproduce head to set up magnetic lines of flux in the loop. The magnitude of this flux is the **average** state of magnetization on the portion of the tape bridging the gap at some particular instant.

This magnetic flux sets up an e.m.f. in the reproduce coil in accordance with the well known formula

$$E = N \cdot (d\phi/dt) \quad (2)$$

This expression shows, for a given maximum input signal, hence maximum flux (ϕ), that as frequency is increased so also is $d\phi/dt$ and consequently the output voltage. This effect would continue except for the fact that the core is "looking" at the **average** flux in the gap, which presumes that the wavelength on the tape must be long in comparison to the width of the gap. However, if the recorded wavelength on the tape is shorter (of higher frequency) and is equal in length to the gap width, then the average flux and hence output

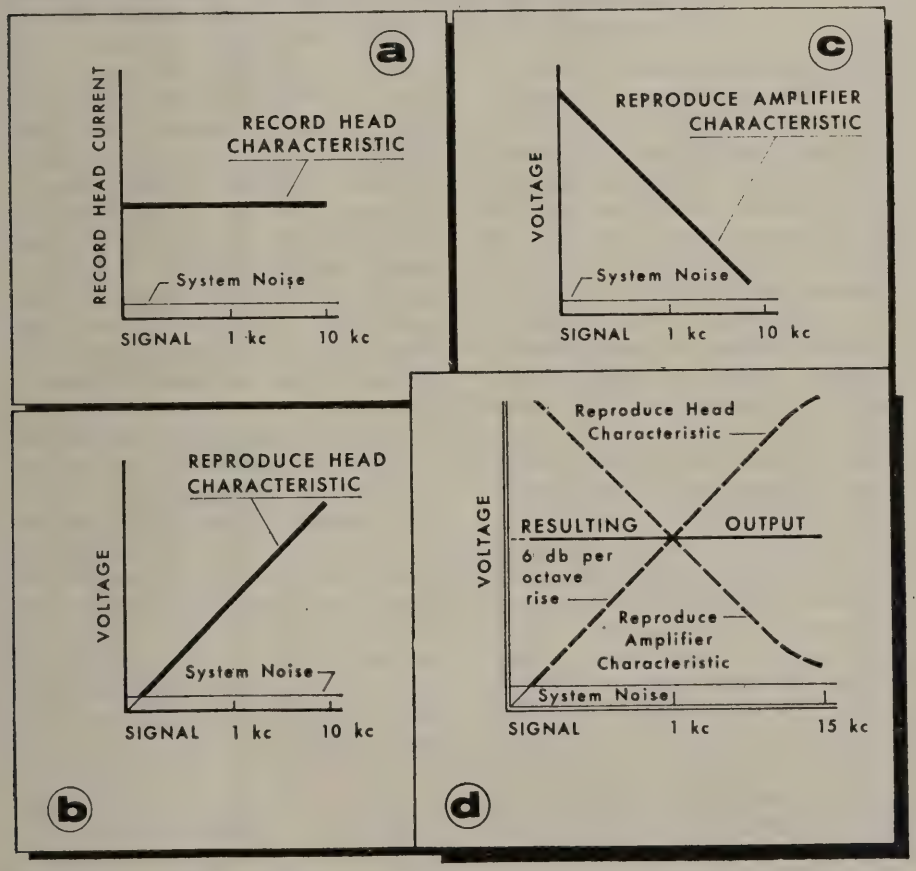


Fig. 3 (above) — Achieving flat overall response necessitates equalisation of the reproduce amplifier. This diagram illustrates various record and reproduce characteristics which result in the desired output.

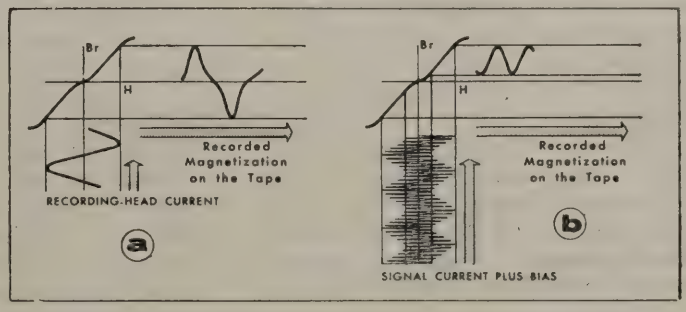


Fig. 2 (right) — This diagram illustrates what the high-frequency bias signal accomplishes. "A" shows resultant distortion with no bias voltage applied, while "B" shows how the bias eliminates the distortion.

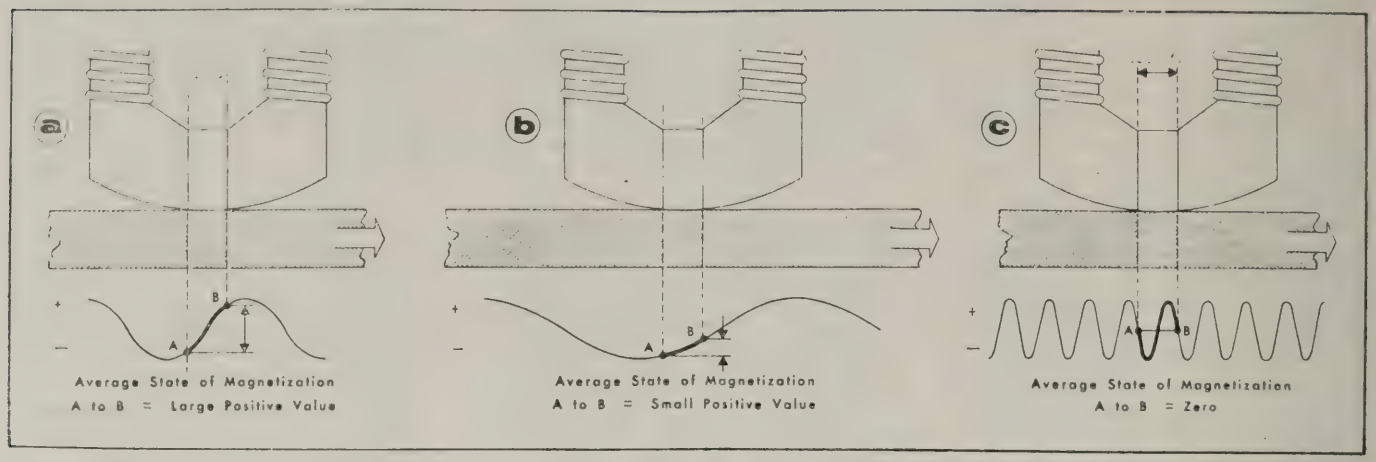


Fig. 4 — How different frequencies react with the reproduce head gap is shown here. In "A" a medium frequency gives a large output; in "B" a low frequency results in a very small output; and in "C" (where the high frequency has the same wavelength as the gap dimension) there is no output. Sine waves are used here to indicate the average state of magnetisation on the recorded tape.

would become zero. As the frequency approaches this condition the voltage output falls off quite rapidly. Figure 4 (c) illustrates this rather major limitation in the direct recording technique.

Since equation (1) shows that the wavelength on the tape is directly proportional to the tape velocity, it becomes apparent that the frequency range of a given tape system, with effective gap width (normally .00008in. to .0001in.) is directly proportional to tape velocity.

There are therefore two means of reducing this high frequency defect, either by reducing the size of the gap, or increasing the speed of the tape. By reducing the gap size, the reproduce head voltage output drops, as shown by the dotted curve in figure 5, thus bringing about a greater signal to noise ratio. (This illustration also shows the relative frequency response for increasing tape velocities.) Increasing the tape velocity, on the other hand, brings about additional wear on the head. The system is usually designed taking both these factors into account to achieve the best balance for the required performance.

The variation of output voltage of the reproduce head, with frequency, is shown in Fig. 3 (b) and in order to obtain an overall flat frequency response characteristic which is inverse to that of the reproduce head characteristic. This technique is called "playback" equalization and the reproduce characteristic as shown in Fig. 3 (c), will give the resulting output signal an overall flat frequency response, as in Fig. 3 (d).

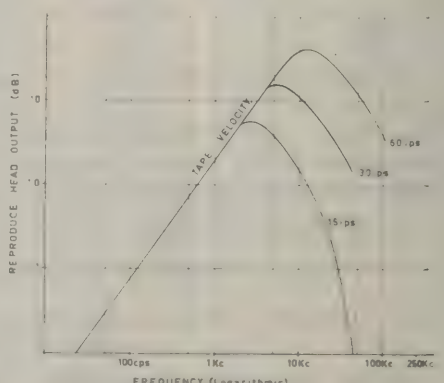
Another serious defect is from "tape dropouts." This is caused by small bumps or modules of magnetic oxide particles formed during the coating of the oxide on the magnetic tape. As these modules pass across the head they cause the tape to be lifted away slightly, and result in a drop in signal level. At high frequencies this "dropout" effect is even more severe if the wavelength of the signal becomes the same size, or smaller, than the actual module. Output variations of 5% to 10% are typical in tape systems and even 50% (6 dB) dropouts are not unheard of. Such effects are inaudible to the human ear, even in high fidelity tape recording — since the ear tends to integrate high speed variations in signal level, but can be detrimental in precision instrumentation recording.

Conclusions

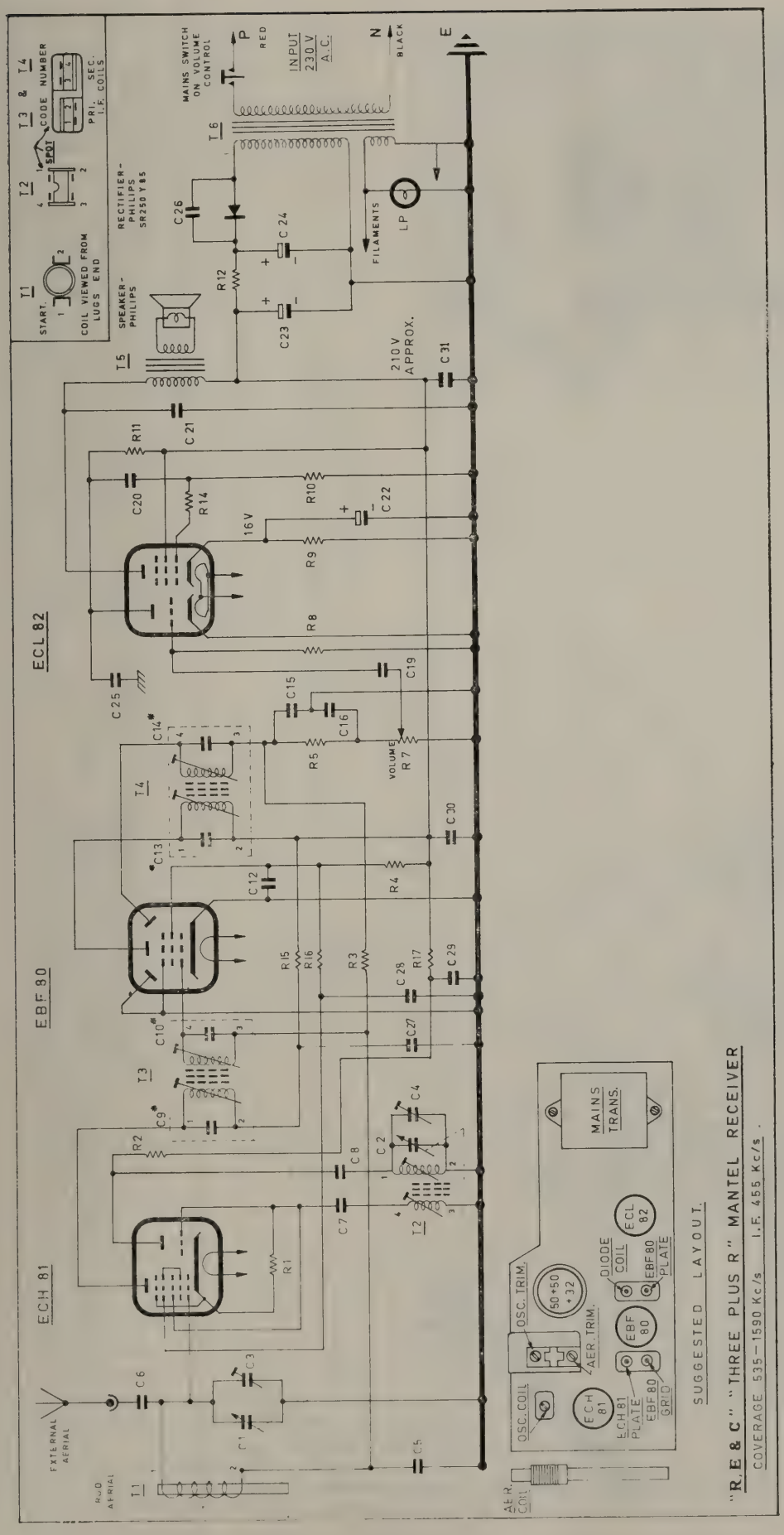
Direct recording has several advantages and disadvantages when compared with other techniques. It has the widest frequency spectrum, and signals can be recorded over a continuous range of between 50 c.p.s. and 250 Kc. In addition it has a wide dynamic range and can handle input overloads without drastic increases in distortion.

Many uses are found for this technique in sound and noise measurements and in multiplexing a number of signals simultaneously on one track by allotting each channel a particular section of the available frequency spectrum.

Nevertheless, the previously mentioned limitations plus the fact that it is impossible to pass D.C. signals in this mode (as can be seen from Fig. 5), show the need for a different technique. These objections can be overcome through the use of F.M. electronics in the technique known as Frequency Modulation Recording, which will be discussed in the second part.



F.3.5 FREQUENCY RESPONSE OF REPRODUCE HEAD OUTPUT.



R. E. & C. "Three Plus R" Mantel Broadcast Receiver

by C. W. Salmon

Whilst transistorised portable radios continue to capture the lion's share of the "portable" market the better audio quality, generally cheaper price and freedom from battery replacements of valve type receivers still make these a favourite for home use.

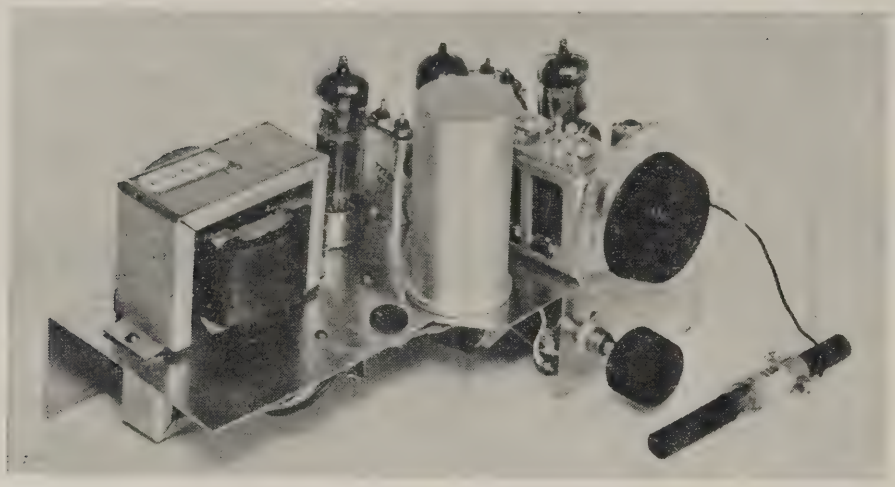
The steady demand for simple valve receivers results in our publishing this month a three-valve receiver circuit and construction details that will appeal to many home constructors. Nominally, it is a four-valve circuit but the rectifier valve has been replaced by a half wave Selenium rectifier stack of equal performance — hence our title "Three Plus R."

The circuit is based upon a successful commercial production but several changes have been made to bring construction and lining up procedures within the scope of home constructors. Whilst the coils and I.F. transformers are of Philips manufacture the circuit could be adapted for similar components of other manufacture. However, the details given are for assembly using the components shown but such items as resistors and capacitors are not critical as to make.

Valve Line-up

Noval nine pin series valves are used, the convertor being an ECH81 followed by an EBF80, an I.F. amplifier-detector with an ECL82 triode-pentode as audio amplifier and power output valve.

See parts list on page 31



The Circuit

Figure 1 shows the circuit employed in the prototype.

T_1 C_1 is the aerial tuning circuit with T_2 C_2 the oscillator circuit shunt fed to the triode section of the ECH81. AVC is fed to the grids of the ECH81 and EBF80 via a 2.7 M ohm. resistor.

Signal rectification is by the R.H. diode of the EBF80 with the audio fed to the triode grid of the ECL82 via the volume control.

Except for rather more decoupling in the H.T. supplies to the R.F. and I.F. end the circuitry is quite standard.

Construction

As it is possible to obtain a plastic cabinet to suit the "Three Plus R" the details given are for those who wish to use this available cabinet. Otherwise, those constructors who prefer to build a cabinet from wood or Formica will have slightly more space for their layout than the commercially available cabinet allows.

Figure 2 shows the location diagram upon which our chassis work is based. The cut back on the top right corner is to allow for the 5in. speaker used. The commercial cabinet also has provision for a special chassis fixing system that we have **not** employed in our prototype as hidden screws would have had to be used. This feature, although not used, requires a chassis shallower than the cabinet.

(Constructors, when using the cabinet, will see the original fixing details and may, in fact, wish to use them. The only need, in this case, is to keep certain components under the chassis clear of the screw and screwdriver holes).

The chassis has been designed with no ends so that it can be folded up at home out of 16 or 18 gauge aluminium, although 18 G steel is to be preferred for screening (see later).

All mounting holes, including the valve holes, can be made with a $\frac{1}{4}$in. drill and a small rat tail file. Better still, a $\frac{3}{4}$in. diameter chassis punch will make neat work of the valve socket holes. For professional finish to the oscillator coil cut out and I.F. transformer cut outs a light, flat file about $\frac{1}{2}$in. across is useful. Nevertheless, patience and a small rat tail file, say, $\frac{1}{4}$in. diameter, will give a satisfactory finish.

Mounting Procedure

Having made the chassis and holes to figure 2 mount, first, the

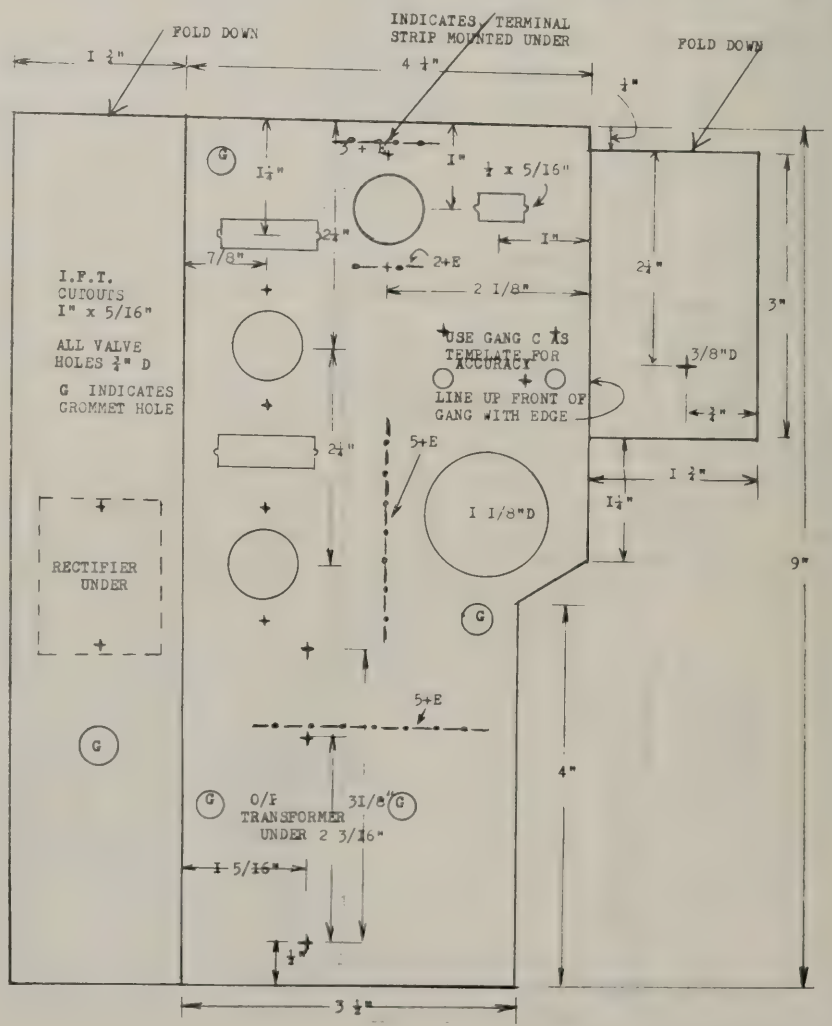


Fig. 2 — Layout Diagram

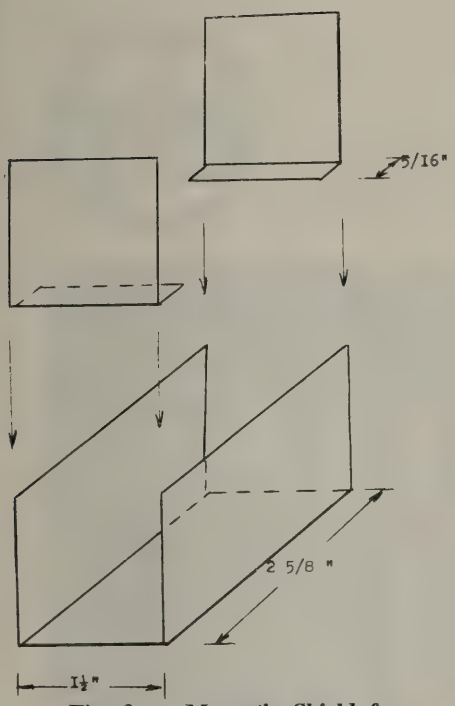


Fig. 3 — Magnetic Shield for O/P Transformer

three valve sockets. Locate V1 socket with pins 8 and 9 nearest to the oscillator coil cutout and pin 2 and 3 of V2 nearest to the first I.F. transformer. Mount V3 socket so that pins 4 and 5 (heater) are nearest the power transformer.

Next mount the two I.F. transformers as shown in figure 2. The coil locations are shown on figure 1. These I.F. transformers are supplied with mounting clips. A small (1/16in. diameter) nick should be made on each end of the mounting cutout to accommodate the foot of the clip. The same should be done for the oscillator coil.

Thirdly, mount the oscillator coil and then the 50 + 50 + 32 μF filter capacitor. Be sure to bend over the lugs on the can very hard so that the can does not turn in its hole.

The tuning capacitor can now be mounted followed, finally, by the power transformer. Do not, yet, unpack the aerial coil or its ferrite rod.

The position of the output transformer will depend upon whether or not the commercial cabinet is purchased. If so, the output transformer will need to be mounted under the chassis below the position occupied by the power transformer. With an aluminium chassis the A.C. field from the power transformer may affect the output transformer and cause a power hum in the speaker. To obviate this details are given of a 16 G steel shield to house the output transformer. This shield is mounted along with the output transformer under the chassis so as to enclose the O/P transformer and place a magnetic shield between the two transformers. A steel chassis will effectively do this, but a steel chassis should be plated to prevent rusting. (The steel O/P transformer enclosure need not be plated but should be painted for protection).

Note 1: If the O/P transformer is mounted under the chassis it is as well to mount it first as one screw will be hidden under the P.T. A common mounting screw can be used for one lug of each.

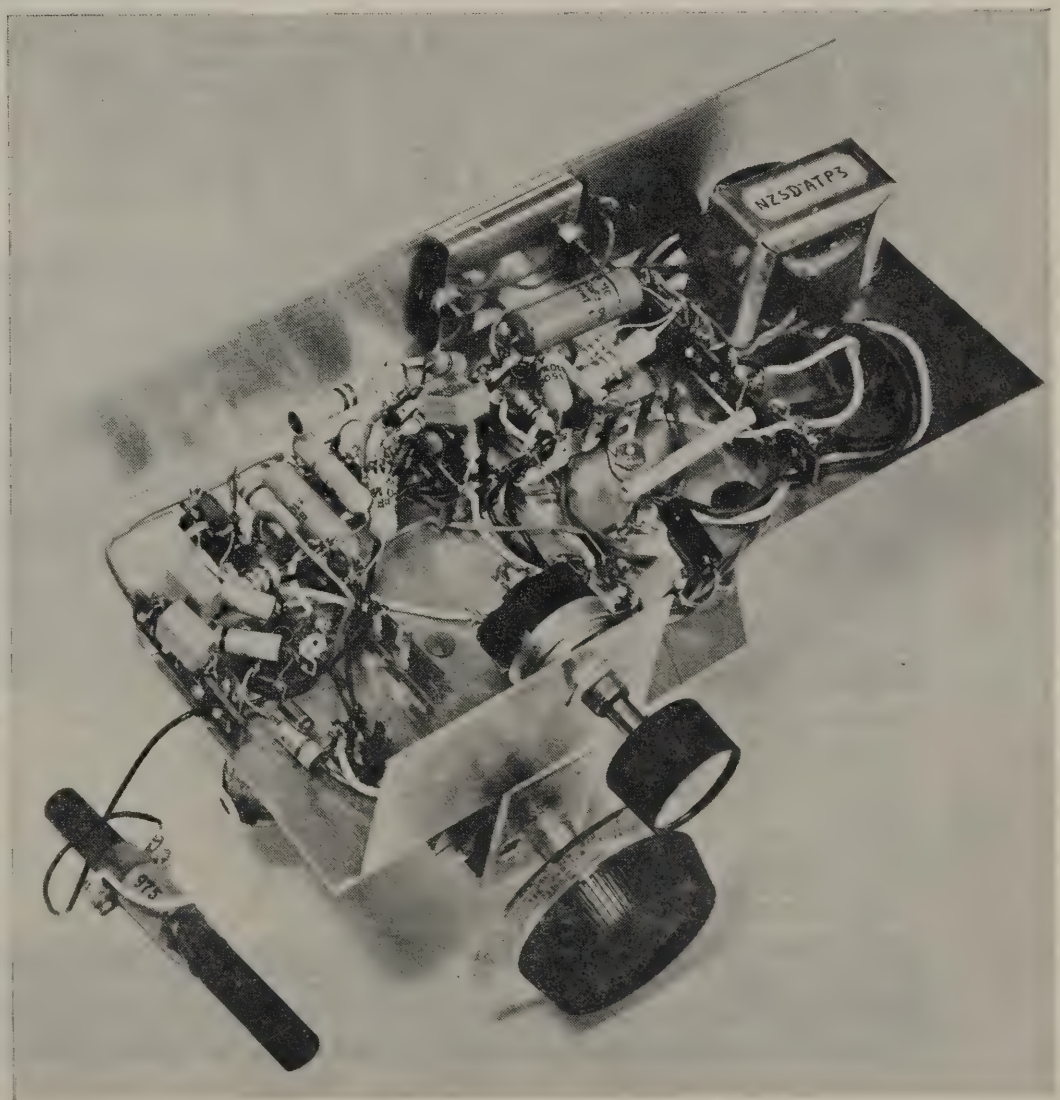
Note 2: Mount tag strips under socket screws as shown in figure 3.

The last item to be mounted is the volume control.

Wiring

Apart from the need to avoid instability in the R.F. and I.F. stages wiring is simple and straightforward. Decoupling has been employed to reduce instability due to feedback and capacitive coupling. Plate and grid leads and components in the ECH81 and EBF80 sections should be well separated and should be dressed squarely and leads cut as short as possible.

To further reduce I.F. instability 100 K ohm. resistors are used across the primaries of each I.F. transformer. Should layout troubles cause instability



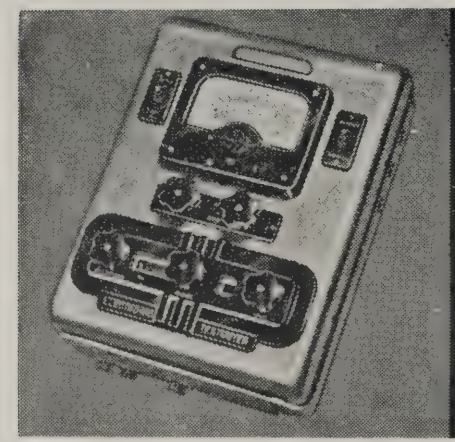
ENQUIRY CARD AD. 10

AVO

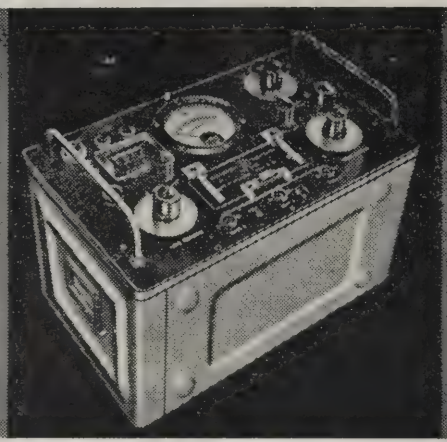
Accurate, dependable

Test Instruments *you can trust*

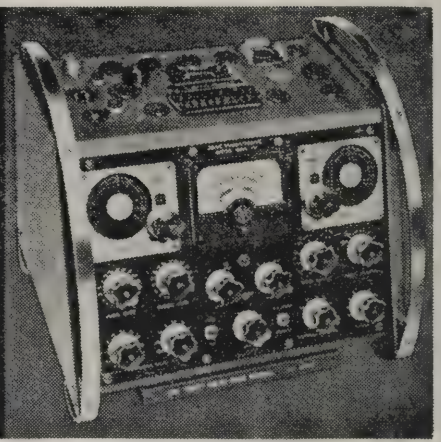
NEECO



Avo electronic testmeter
A 56 range valve voltmeter for the electronic engineer capable of making a very wide range of measurements not normally covered by this type of instrument. The measuring circuits employ very high input resistances even when low voltage ranges are in use.



Avo Electronic Multimeter
This 95 range instrument consists basically of a highly stable balanced valve d.c. millivoltmeter with a full scale sensitivity of 250 mV, a radio frequency diode head, a decade radio-frequency amplifier, voltage multipliers, shunts, wattage load circuits and a valve stabilised power supply.



Avo valve characteristic meter, Mk. IV
A most comprehensive bench type Valve Tester which will test most standard receiving and small power transmitting valves on any of their normal characteristics under conditions corresponding to any desired set of d.c. electrode voltages.

Avo valve Tester, Type 160
This portable instrument will check most standard receiving or small transmitting valves and will produce accurate readings of mutual conductance. It can be easily operated by an unskilled person.

There is also a full range of AVO Measuring and Precision Instruments.

Avo universal measuring bridge, Type 1
A self-contained mains driven model, this instrument has 24 calibrated ranges for the measurement of resistance, capacitance and induction.

Avo transistor analyser
A portable or mains instrument for measuring transistor parameters in the grounded emitter configuration. *Ranges:* Current: 0-100 uA, 0-1mA, 0-10mA, 0-100mA, 0-1A. Voltage: 0-1.5v, 0-15v, 0-150v, with a sensitivity of 20k ohms. The movement is protected against damage by overloads.

A1.4

NEECO THE NATIONAL ELECTRICAL AND ENGINEERING CO LTD

AUCKLAND WELLINGTON CHRISTCHURCH DUNEDIN WHANGAREI HAMILTON ROTORUA NEW PLYMOUTH WANGANUI HASTINGS LOWER HUTT INVERCARGILL

secondary padding of 100 K ohms. should be tried.

Two .047 μF capacitors are shown from the H.T. line to ground. Physically these are located one at the junction of R12 and C24 tied to the capacitor lug and the other from lug 2 of I.F.2 (T4) directly to the nearest earth point.

(A) Lining Up with Signal Generator

Solder the aerial coil T1 into the circuit but do not insert the ferrite rod and proceed as shown below:

(B) Lining Up Without Signal Generator

Whilst this is not an accurate method the non-availability of a signal generator may initially require it. Insert the aerial rod before commencing this method.

(1) Connect aerial lead of set to a **good** aerial and make sure a good earth is present and tune to position on dial corresponding to most powerful local station.
(2) Proceed as A1-4 above—the selected station should be heard, first, weakly and then better as the I.F.'s are brought into line.
(3) If (2) is successful tune to station nearest, say, 600 Kc/s or 700 Kc/s and proceed as for A5 and 6.
(4) Then tune to a station near 1200 Kc/s or 1300 Kc/s and proceed as for A7 and 8.
(5) Operate as for A9 and 10.

Signal	Connect to	Adjust for Maximum Output
455 Kc/s	Grid ECH81 via .01 μF	(1) T4 Secondary (2) T4 Primary (3) T3 Primary (4) T3 Secondary
Now insert ferrite rod in A.E. coil		
600 Kc/s	Aerial	(5) Oscillator coil (6) Coil on ferrite rod
1400 Kc/s	Aerial	(7) Oscillator trimmer on gang (8) Aerial trimmer on gang
600 Kc/s	Loosely couple aerial to rod	(9) Coil on rod
1400 Kc/s	Loosely couple aerial to rod	(10) Aerial trimmer on gang

Repeat all steps several times in sequence.

Aerial Coil Position

It will be noted that no mention has been made of mounting the aerial coil and ferrite rod. This can be mounted according to the cabinet chosen but it will be found that the commercially available cabinet does not allow the rod to be mounted flat on the chassis. It can, however, be (a) mounted vertically adjacent to the ECH81 and the oscillator coil by drilling a chassis hole (and grommet this) to take the rod and securely gluing the rod into the grommet with Uhu glue, or (b) by mounting the rod horizontally off the chassis on non-metallic supports — these could be paxolin strip mounted on the chassis with L-shaped metal feet close to the LH edge of the chassis.

It will be noted that the chassis fits into the cabinet on rails and that once in the cabinet there is an extra ⅜in. or so on each side of the chassis against the cabinet wall.

Mount the speaker before inserting the chassis into the cabinet.

—Continued on page 33

PARTS LIST — Refer page 27

RESISTORS

R1	47K	½w	5% Cracked Carbon	Code B8.305.05B/1K
R2	15K	1	5% Cracked Carbon	Code B8.305.07B/15K
R3	2.7m	½w	10% Cracked Carbon	Code B8.305.05A/2M7
R4	33K	1w	5% Cracked Carbon	Code B8.305.07B/33K
R5	47K	½w	5% Cracked Carbon	Code B8.305.05B/47K
R7	500k	LOG	Potentiometer with DP Switch	Code EO98CD/60E13 (14)
R8	6.8m	½w	10% Cracked Carbon	Code B8.305.05A/6M8
R9	570m	1w	5% Cracked Carbon	Code B8.305.07A/47OE
R10	1.8m	½w	10% Cracked Carbon	Code B8.305.05B/1M8
R11	220K	½w	5% Cracked Carbon	Code B8.305.05B/22OK
R12	1K	5w	10% Wirewound	Code 8354OB/1K2
R14	1K	½w	5% Cracked Carbon	Code B8.305.05B/1K
R15-R17	10K	1w	Carbon	

CAPACITORS

C1	10-332 pf)			
C2	9-132 pf)			
C3	3-30 pf)		Tuning Capacitor	49.002.00
C4	3-30 pf)			
C5	.047 uF	125 volts	Polyester 10%	C296AA/A47K
C6	12 pf	700 volts	Ceramic Safety Type	C321GA/A12E
C7	47 pf	500 volts	Ceramic Tubular 5%	C304GH/C47E
*C8	150 pf	500 volts	Ceramic Tubular	C304GH/C15OE
C9	195 pf	In I.F. can		
*C10	195 pf	In I.F. can		——
C12	.082 uF	400 volts	Polyester	C296AC/A82K
*C13	195 pf	In I.F. can		——
*C14	195 pf	In I.F. can		——
C15	100 pf	500 volts	Ceramic Pinup	C322BC/P100E
C16	100 pf	500 volts	Ceramic Tubular	C304GH/C100E
C19	10K	30 volts	Polyester Pinup	C280AA/P10K
C20	10K	400 volts	Polyester	C296AC/A15K
C21	15K	1000volts	Paper Safety Type	C101CD/A15K
C22	32	350 volts)		
C23	50	350 volts)	Triple Electrolytic	AC.5483/50+32+32
C24	32	350 volts)		
C25	220	500 volts	Ceramic Tubular	C304GH/D220E
C26	390	700 volts	Ceramic Safety Type	C321GA/A390E
C27-C31	.047 uF	400 volts	Polyester	C296AC/A47K

COILS, TRANSFORMERS, SPEAKERS

T1	Aerial Coil	EN.469.75
	Ferroxdure Rod for Aerial Coil	56.681.25/4B
T2	Oscillator Coil	EN.471.67
T3	IF Transformer	A3.127.72
T4	IF Transformer	A3.127.72
T5	Output Transformer	NZSD.ATP3
T6	Power Transformer	NZSD.ATP5
	Loudspeaker 5"	AD 3513Z

VALVES, ETC.

Frequency Connector	ECH 81
IF Amplifier and Detector	EBF 80
Audio pre amp and Output Stage	ECL 82
High Tension Rectifier	SR250Y85

MECHANICAL

Valve Sockets	B9A x 3
Dial Knob—Brown	A3.769.02
Dial Knob—White	A3.772.65
Dial Knob—Black	A3.772.67
Dial Knob Screws x 2	BO.61DD/3 x 12
Dial Knob Nuts x 2	BO.18AE/3
Dial Scale	EN.852.73
Dial Scale Screws x 2	BO.55ED/3 x 6
Volume Control Knob	NZSD.SA.1642
Cabinet—Black and White)	NZSD.187X
Cabinet—Brown and Cream) Specify	NZSD.187X
Cabinet—White and Black)	NZSD.187X
Cabinet—Maroon and White)	NZSD.187X
Spring for Mounting Osc. Coil	A3.652.75
Spring for Mounting IF's x 2	A3.652.58
Dial Lamp	8008D
Dial Lamp Holder	NZSD.SA.4110
Mounting Strips	2 + Earth 1
Mounting Strips	3 + Earth 1
Mounting Strips	5 + 2 Earth 2

ENQUIRY CARD AD. 11

Advance

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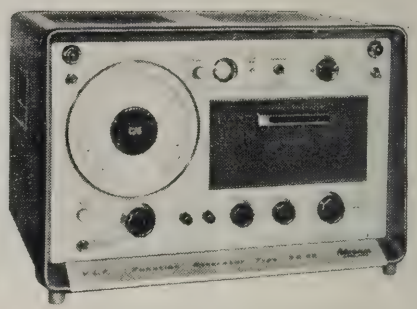
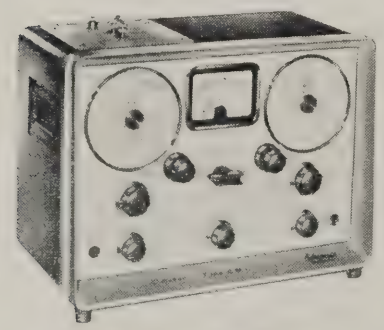
SG88

V.L.F. Function Generator

Frequency range 0·005c/s to 50c/s for single cycle disc. Higher frequency is possible by use of 2, 3 or 4, etc., cycle disc. *Calibration* ±1% full scale. *Output* VOLTAGE Continuously variable from 200μV to 22V pk.pk. AMPLITUDE VARIATION Within 1dB over entire frequency range. IMPEDANCE At maximum output 6kΩ, mid setting 16kΩ, depending on frequency. WAVEFORMS Any single valued repetitive function. *Facilities* Direction of rotation of the waveform disc can be reversed, thus reversing the time sequence of the waveform. Automatic frequency sweep device on the 0·5 to 5c/s and 5 to 50c/s bands. Sweep time is approximately 2 minutes for any 10:1 frequency excursion. Four waveform discs (sine, square, sawtooth and white noise) and one blank disc supplied. Special discs made to order. *Power requirements* 105 to 125V, 190 to 250V, 50 to 60c/s, 165W. *Dimensions* 19¾in (50cm) wide × 13in (33cm) high × 15in (38cm) deep. *Weight* 80lb (36kg).





CM1

'Q' Meter

'Q' range 15 to 600 in two bands. *Oscillator frequency* 100kc/s to 100Mc/s in six bands. *Frequency accuracy* ±1%. Stabilised signal level. *Main capacitors* Capacitor scales 10 to 70pF (±1pF), 40 to 600pF (±2%). Reactance (Xf) scales 16000 to 2200Ω–Mc/s; 4000 to 300Ω–Mc/s. Inductance (Lf²) scales 2500 to 350μH–Mc/s²; 600 to 50μH–Mc/s². *Incremental capacitor* ±5pF (on 40 to 600pF range of main capacitor) in divisions of 0·2pF. *Accuracy of inductance measurement* ±(5% + residual inductance of 0·035μH). *'Q' range* 15 to 150, 60 to 600. *Accuracy* ±(5% + 5% F.S.D.) below 50Mc/s. For frequencies above 50Mc/s and 'Q' readings above 400 the tolerance should be doubled. *'% Q' scale* Range ±10% (relative to nominal 'Q' reading). *Power requirements* 105 to 125V, 195 to 225V, 225 to 260V, 50c/s (models to suit other frequencies can be supplied). *Dimensions* 18in (46cm) wide × 14in (35·5cm) high × 9½in (24cm) deep. *Weight* 38lb (17kg).

T2

'Q' Meter

'Q' range 10 to 400 in two bands. *Accuracy* ±(5% + 5% F.S.D.) below 50Mc/s. *Oscillator frequency* 100kc/s to 100Mc/s in six bands. *Accuracy* ±1%. *Main capacitors* Capacitor scale 40 to 550pF (±2%). Reactance (Xf) scale 4000 to 300Ω–Mc/s (±2%) Inductance (Lf²) scale 600 to 50μH–Mc/s² (±2%). *Incremental capacitor* 2·5pF. *Accuracy of inductance measurement* ±(5% + residual inductance of 0·03μH). *'% Q' scale* Range 10% (relative to normal 'Q' reading). *Accuracy* ±1% (i.e. ±1 division up to 50Mc/s). *Power requirements* *110 to 120V, 200 to 210V, 220 to 230V, 240 to 250V, 40 to 60c/s, 20W. *Dimensions* 15½in (39cm) wide × 10½in (26cm) high × 6½in (16·5cm) deep.

Weight 14lb (6·5kg).

**Special model available T2E 110 to 125V, 130 to 140V, 160V, 220V, 40 to 60c/s.*

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Sole New Zealand Representatives

TURNBULL & JONES LTD.

Auckland Wellington Christchurch Dunedin

FROM THE COMPREHENSIVE RANGE OF Advance INSTRUMENTS AND EQUIPMENT

R.E. & C. 5in. TV RECEIVER

—Continued from page 17

the "Q" of the coils to the point where the correct bandwidth is obtained. The coil L1 is not damped with a resistor because the loading of the output coil in the tuner coupled through the coaxial cable is sufficient. Similarly L5-L6 also does not require a swamping resistor because of the loading reflected back on the coil from the 4.7k. diode load via the OA85 diode.

Turning now to the coils L8 and L9 in the sound I.F. section, operating at 5.5 mc/s. Here there is only need for the coil to exhibit even response over a range of + — 50 kc. from the centre frequency of 5.5 mc/s. Consequently conventional double tuned I.F. transformers are constructed. The coil L10, operating in the EH90 F.M. detector is a single winding also tuned by a fixed capacitance. This coil is swamped by a fixed resistor to provide the correct operating "Q" for this circuit, but we will discuss this part a little more, later in these articles.

R.E. & C. "THREE PLUS R"

—Continued from page 31

Chassis Fixing

As mentioned above the fixing methods employed in the cabinet are not especially suited to the chassis we have designed as they employ "blind" screws.

It is suggested that the chassis be retained in the cabinet by two L brackets of, say, ⅜in. x ⅜in. fixed neatly with small plated screws, countersunk if possible, towards the rear inside edge of the two sides of the cabinet so located that, after the chassis is slid in, self tapping screws passed through these brackets into the chassis deck.

Dial Light

This can be located to suit the constructor's convenience.

Construction time: 8 hours. A final line up with own or local serviceman's signal generator is well worthwhile.

Thanks are due to Philips Electrical Industries Ltd. for components supplied to suit the prototype.

ENQUIRY CARD AD. 13

Radio Mr^ Serviceman

Our radio broadcast universal replacement coils will replace any damaged aerial, R.F. or oscillator coil. Designed to assist you in maintaining first-class service to your clients.

Aerial Type 40
R.F. Type 45
Osc. Type 41

Write for alignment procedure Sheet No 5/40

New factory address:
Cameron Rd. South, Greerton, Tauranga

Inductance Specialists LTD.

ENQUIRY CARD AD. 12

PRINTED CIRCUITS!
LOOK AT THE PICTURE . . .
NOW LOOK AGAIN!

Do you see the clean, straight lines — no fuzziness at the edges — no undercutting of copper.

These printed circuit boards are truly PRINTED not silk screened. Manufactured on an Ozaplan machine designed for the purpose, constant top quality is assured over any size runs. Because of this method of manufacture we can guarantee top quality, consistency and reliability.

Additional features include thicker boards, thicker copper, all boards flux dipped and protected at no extra cost, rivets provided in essential holes subject to frequent component removal. All holes precision drilled to conform to any configuration. Reverse printing available showing components and values, etc. Plug in facilities available.

We provide a full Design, Drawing and Processing service. Send us your problems — large or small — we shall see them through to completion.

Fast and efficient prototype service available.

STAY WITH THE TIMES — USE PRINTED CIRCUITS AND CALL ON

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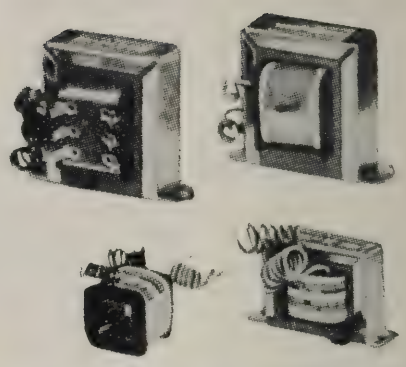
ENQUIRY CARD AD. 23

OUTPUT TRANSFORMERS to your requirements

by ATC



We Manufacture many types of Output Transformers for New Equipment and Replacement Repair Work.
WINDINGS AVAILABLE FOR OP1-14 and OP18-22 INCLUSIVE

Type No.	Wattage	Impedance Ratio	Bobbin Size	Colour Code	Mounting
†OP1	3	5K/3 ohms	9/16 Square	Red	Clamp
†OP2	3	7K/3 „	9/16 „	Yellow	„
†OP3	3	10K/3 „	9/16 „	White	„
†OP3 C	3	10KCT/3 ohms	9/16 „	White	„
†OP4	6	5K/3 „	¾ Square	Red	„
†OP5	6	7K/3 „	¾ „	Yellow	„
†OP6	6	10KCT/3 „	¾ „	White	„
†OP7	6	14KCT/3 „	¾ „	Black	„
†OP8	4.5	5K/3 „	11/16 x 13/16	Red	„
†OP9	4.5	7K/3 „	11/16 x 13/16	Yellow	„
†OP10	4.5	10KCT/3 „	11/16 x 13/16	White	„
†OP11	4.5	14KCT/3 „	11/16 x 13/16	Black	„
†OP12	4.5	Universal	11/16 x 13/16	—	„
†OP13	6	Universal	¾ x ¾	—	„
†OP14	10W	Universal	⅞ x ⅞	—	„
OP15	20	5KCT/Univ.	1" x 1¼	—	Side covers & feet
OP16	20	6.6KCT/ „	1" x 1¼	—	„
OP17	20	10KCT/ „	1" x 1¼	—	„
OP21	2W	5K/3	½"	Red	Windings Only
OP22	2W	7K/3	½"	Yellow	„ „
OP23	35W	5KCT/Univ.	2" x 1¼	—	Covers & Feet
OP24	35	6.6KCT/ „	2" x 1¼	—	„ „
OP25	35	10KCT/ „	2" x 1¼	—	„ „
OP26	15W	Hifi 5KCT/15 ohms	2" x 1¼	—	„ „
OP27	15W	Hifi 8KCT/15 „	2" x 1¼	—	„ „
OP28	15W	Hifi 10KCT/15 „	2" x 1¼	—	„ „
		ULTRA LINEAR TYPE			
OP29	20W	5.6KCT/15 ohms	2" x 1¼	—	„ „
OP30	20	8.5KCT/15 „	2" x 1¼	—	„ „
OP31	20	10KCT/15 „	2" x 1¼	—	„ „

LOW POWER EXTENDED RANGE

OP32	6W	8KCT/7 ohms	1¼" x ⅞"	—	Clamp
OP33	6W	8KCT/15 „	1¼" x ⅞"	—	Clamp
OP34	3W	Universal	9/16 x 9/16	—	„
OP35	6W	10KCT/15-7.5-3 ohms	¾ x ¾	—	„
OP36					
OP37 / OP50	8W U/L / 10W stereo	9KCT/15-7.5-3 ohms	⅞" x ⅞"	—	„

Auckland Transformer Co. Ltd.

20 EDEN STREET, NEWMARKET, AUCKLAND

TELEPHONE 51-307 — — — — TELEGRAMS: "TRANSFORMA," AUCKLAND

On the Record

by Ray Wilson, Mus. Bac.

ANTON BRUCKNER: Mass in F Minor. Pilar Lorngar, soprano; Christa Ludwig, contralto; Josef Traxel, tenor; Walter Berry, bass; the choir of St. Hedwig's Cathedral and the Berlin Symphony Orchestra, conductor Karl Forster. His Master's Voice ALP 1964.

In English-speaking countries, Bruckner has not received the acclaim of critics or musical public. For some reason, this dynamic composer, so popular in Austria and Germany, has never broken through like Brahms and Wagner have done. These days, the feuds of the mid-nineteenth century are all but forgotten, but the white-hot partisanship of the period has perhaps never been seen before or since in the musical field. Austria has always had its fair share of musical politics and during the latter part of Bruckner's life Vienna was a hot-bed of intrigue, rumour and counter-rumour. This disturbed atmosphere may have had its effect on Bruckner's music — although even today the average musical Viennese is a person of strong opinions, rigid standards and acidic, if witty outspokenness.

This Mass in F Minor is one of the world's great choral masterpieces. Parts of it, indeed most sections, must stand with the Mass in B Minor of Bach, and the Missa Solemnis of Beethoven. And yet its virtues are not so evident on the first hearing. The composer, a devout Catholic, has provided us with music of a lyrical nature, but with a dramatic forthrightness too seldom seen in religious compositions. Written for solo-quartet with four-part choir, the work abounds in harmonic and contrapuntal interest and should provide an excellent introduction to music by this little-known composer.

This performance is very satisfactory. Although I prefer the D.G.M. recording for its superior orchestral playing and greater emphasis of dramatic qualities, the quality of St Hedwig's Cathedral choir has been excellently recorded — in fact, the recording is one of the best, from a technical point of view, I have heard for some time. Try it !

BEETHOVEN: Missa Solemnis, with Elisabeth Schwarzkopf, Christa Ludwig, Nicolai Gedda, Nicola Zaccaria with the Singverein der Gesellschaft der Musikfreunde and the Phailharmonia Orchestra conducted by Herbert von Karajan. World Record TZ 214-215.

Karajan is widely recognised on the Continent as a Beethoven interpreter. His latest recordings of the Beethoven symphonies are as great in their way as the famous Toscanini versions.

Karajan received a lot of experience with the human voice in his early days, first as conductor of a church choir and later in the opera house, and this serves him well when dealing with a large choir and the difficult vocal parts Beethoven presents to them and to the soloists.

The Singverein in Vienna has an enviable reputation. In a year it will sing all the major choral works, the Brahms Requirem, the Verdi the St. Matthew Passion, the B Minor Mass and so on with a couple of weeks rehearsal. The members literally know the notes and words by heart, and the lucky conductor who engages them for a disc like this finds their musicality so great that he can easily mould them to his own design and plan.

On the other side of the picture, I have never thought their sopranos first class, and this set confirms my opinion. It is my only criticism. The rest of the choir sings with verve, beautiful tone and ensemble, and likewise the orchestra, who excel themselves with the chorus in the more difficult parts, e.g., **Vitam venturi** and the opening of the **Gloria.**

My discs had a fair amount of surface noise, but for an oldish recording the sound is excellent. Karajan is served well by his soloists, Ludwig being particularly impressive. I venture to say that today his reading would be less "romantic" and with greater dynamism, but the performance presented here has many excellent features and you could well buy it if you have no other version.

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MICROELECTRONICS

The tiny shape of things to come

— from page 12

a unit may be called on to cater for widely differing bandwidth, linearity and power level demands; it usually follows from this that tolerances are critical. For these reasons, thin films or the multichip semiconductor techniques are more readily applicable to linear circuitry whilst the singlechip semiconductor approach is at present virtually confined to digital circuits.

An interesting example of the transition from laboratory experimental work to practical hardware can be seen in the Marconi "MYRIAD" digital computer, which created quite a stir when it was put on show for the first time at the 1964 IEA exhibition in London. This computer, which uses the multichip configuration, is ten times faster than its conventional-component predecessor, a feature made possible by the microminiaturization, which shortens the delay times by reducing the length of the computer interconnections to a minimum. Here, in action, is one practical advantage of microelectronics, to which may be added a greatly improved reliability factor, greater ease of maintenance and a reduction in power consumption. The cost of the new "MYRIAD" is no greater than that of its predecessor. At the same time the physical size has been greatly reduced, for whereas its nearest equivalent in conventional equipment occupies four standard 7ft. racks and a control desk, the "MYRIAD" is housed completely in one compartment of a control desk only. This computer will carry out 30 million orders every minute.

In order to assess the values of multi-chip semiconductor techniques in the formation of linear circuits Marconi's have also carried out an exercise involving the manufacture of a micromin airborne 75 Mc/s Marker Receiver. In such equipment a reduction in size is of course important, and in fact this experimental Marker Receiver occupies less than one-quarter of the volume taken up by its conventional counterpart, which itself is small. More important still, in a situation in which the lives of a hundred or more passengers may depend upon it, is the reliability factor; in this respect the experimental micromin receiver has a calculated mean time between failures of 34,000 hours, as against the 10,000 hours of the latest conventional Marker Receivers now going into airline service.

We are, as yet, a long way from the idealized black box consisting of one tiny piece of semiconductor without identifiable components in it. It may be that goal will never be wholly reached, but even if it is not, enough knowledge presently exists to indicate that here to hand in microminiaturization is the technique of the immediate future for large areas of electronics manufacture.

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NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

ULTRASONIC SENSORS IN BATCH COUNTER

Ultrasonic sensors are used in a new multipurpose batch counter capable of counting up to six digits at 750 counts a minute. Ultrasonics have several advantages over other forms of detection. The sensor heads do not need cleaning and are unaffected by dust, steam, and ambient light. There are no lamps or tubes to wear out, and transparent objects can be sensed.

ENQUIRY CARD 54

* * *

SEMICONDUCTOR SIGNAL GENERATOR

A new signal generator, providing a high quality amplitude modulated output from 10 kc/s to 72 Mc/s, is being produced by a British firm. It is believed to be among the first of its type to use semiconductors throughout instead of valves. It is compact (28 cm. x 46 cm. x 36 cm.), weighs only 23 kg., and can be used on a bench or in a rack. It can operate either from mains electricity supply or from a 24 volt battery (with simple switch adjustment). Each of the eight bands in the frequency range has its own permeability tuned oscillator and output stage. Carrier frequency can be checked against built-in crystal controlled sources at intervals of 10 kc/s, 100 kc/s or 1 Mc/s, and can also be verified at points plus or minus 1 kc/s from these frequencies. At carrier frequencies of 100 kc/s and above, an incremental tuning control can be used to vary carrier frequency by very small amounts, giving high discrimination and tuning efficiency on an effective scale length of 4 km.

ENQUIRY CARD 55

* * *

ELECTRONIC RADIO RESEARCH TO BE CO-ORDINATED

Electronic and radio research in Britain — both by Government and industry — is to be co-ordinated by the National Electronics Research Council, believed to be the first council of its kind in the Commonwealth. At the first press conference of the Council held in London recently it was announced that the governing body is to consist of the permanent secretaries of the Ministry of Aviation, the Board of Trade, and Ministry of Defence, as well as representatives of the Ministry of Education and Science, the Post Office, various universities and technical colleges and the chairman of the leading electronics manufacturers. The National Electronics Research Council will consider further fields for British research, show where additional effort is required and how to avoid unnecessary duplication. It also aims to ensure that new ideas arising from defence projects which are released from the "secret list" and from speculative research in universities are made available for adoption and exploitation by industry with the minimum delay. Other objects include arrangements for financial backing of research projects which are too expensive for individual companies or single universities to manage on their own, to provide a Central Information Service covering all the latest developments in electronics research and, by reviewing the granting of scholarships and awards, to ensure that more research workers become available.

ENQUIRY CARD 56

* * *

GUIDE TO BRITISH ELECTRONIC VALVE INDUSTRY

A guide to the structure of the British electronic valve and semiconductor industry, first published two years ago, has now been brought up to date. It classifies 62 types of valves, tubes and other devices and gives the

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names of the firm making each type. British production of electronic valves and tubes is about 100 million units a year.

ENQUIRY CARD 57

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ELECTRONIC ENGINEERING: LONDON CONFERENCE

A one-week conference on components and materials used in electronic engineering is to be arranged in London next year by the U.K. Institution of Electrical Engineers (May 17-21, 1965). It will run in conjunction with the Radio and Electronic Component Show. Subjects to be discussed are recent developments in active and passive components, including integrated circuits, and in the materials of which they are made.

ENQUIRY CARD 58

* * *

FIRST LINK IN FAR EAST CABLE COMPLETED

The first section of Seacom, the Commonwealth South-East Asia telephone cable, which will eventually link Singapore, Jesselton and Hong Kong, has been completed, it was announced in London recently. Some 670 miles of deep-sea cable with 33 repeaters have been laid in six days from Jesselton towards Singapore by C.S. Mercury (8,960 tons). Work began on the second section of the cable recently and will be carried out by H.M.T.S. Monarch. The full operation involves the laying of some 2,000 miles of cable in the China Sea and is the first stage of a Commonwealth undertaking involving Australia, Canada, Malaysia, New Zealand and Britain. Seacom is expected to be in public service early next year. When completed it will join Singapore and Hong Kong to Compac (Commonwealth Pacific Telephone Cable) which was opened at the end of last year, and to Cantat (the Canada/United Kingdom link which has been in service since 1962).

ENQUIRY CARD 59

* * *

ADVANCED COMPUTER CONTROL SYSTEM AT STEEL WORKS

An oustanding feature of a £32 million steelworks development in Britain is what is said to be one of the most advanced examples of industrial computer control in the world. Three linked digitial computers are used for integrated production control. A production planning computer system undertakes the main planning duties for the whole works, covering operations from steelmaking to the finishing mills. The main functions of the system are: The grouping of incoming orders into suitable quantities for steel making, while allowing for steel analysis, furnace availability, mill set-up requirements, delivery commitments and other factors: the issue of appropriate working schedules to the various production departments; and the control of the progress of individual order items to ensure that specifications and delivery requirements are met. Production control is applied by a second computer through the on-line production control system in the primary mill area — that is, from ingot reheat furnace to billet cooling banks. Its many duties include the acceptance of "pit tapes" from the production planning computer; matching ingots drawn from the reheating furnaces to the appropriate order identity and processing requirements; tracking each ingot and its products through the primary mill area; the display of current processing instructions and all relevant data to the operators; the transfer of current shearing requirements to the billet shear computer; the transfer of the current programme number to the bloom mill automatic programmer; the collection of data on actual ingot weights and sheared bloom and billet lengths; and the preparation of a report tape for the production planning computer. The third computer directs the operations of the flying shear in the continuous slab and billet mill. It completes the automatic chain that starts with the receipt of a customer's order and extends through the planning and production control systems to the actual cutting of the order. It ensures that the ordered items are cut with minimum waste and that they are correctly identified. The most obvious value of the system lies in the reduction of tail-end waste. It makes an accurate predition of the total rolled length of each slab or billet, determines the cutting length, and feeds this as a cutting instruction to the shear control. The development scheme includes new steel-making plant, a bloom mill with automatic programming equipment, a continuous slab and billet mill, and a continuous narrow hot strip mill. It will increase the output of steel from 425,000 to 800,000 ingot tons a year. All the major items of plant are now in production.

ENQUIRY CARD 60

* * *

CONTACTOR HAS LIFE OF MORE THAN 100 MILLION OPERATIONS

A new contactor developed for use with high-speed counting devices is said to have a much longer working life than microswitches and conventional car contacts, being still suitable for use even after 100 million operations. It is linked mechanically to a counting device and any working ratio from 1:1 to 100,000:1 can be supplied. The contactor incorporates two reed switches and a rotating shield that interrupts the flow of current through the switches. Magnets are mounted in insulating board, and when the rotating shield covers or uncovers the magnets, the circuits are opened and closed respectively through each reed switch.

ENQUIRY CARD 70

* * *

UNDERWATER "TALKIE" EQUIPMENT FOR SKIN DIVERS

Skin divers will be able to talk to each other under water or to a boat over distances of up to a mile by using equipment developed in the Electrical Engineering Department of Birmingham University. The equipment, called a communicator, is about to go into commercial production. It uses ultrasonic energy to carry a voice signal — a system similar to broadcasting but employing sound instead of radio waves. The equipment is simple in principle. The diver speaks through a throat microphone and the signals from his voice are used to modulate a continuous train of sound waves generated at 120 kilocycles a second. This is produced in a small pack on the diver's back, containing a crystal which rapidly expands and contracts as an electric current is applied to it. This "broadcasts" the sound waves. The receiver works in reverse. Incoming sound waves cause the crystal to vibrate, producing electric current corresponding to the carrier wave with its message. The message is separated and used to make the sound the diver hears in his earphones. If the equipment is carried on a boat to talk to divers the crystal is lowered into the water at the end of a rod.

ENQUIRY CARD 62

* * *

DEMONSTRATION MICROWAVE LINK

To further its expanding overseas trade in microwave telecommunications equipment, a British firm is building for visiting buyers a demonstration microwave radio telephone and television link in Kent, England. Overseas buyers will see the new equipment bouncing telephone calls and TV pictures back and forth between a 100-foot high tower and a smaller tower two miles away. Since a true long-distance link would be impracticable for demonstration purposes this link will be made to simulate one about 175 miles long by sending the radio signals back and forth for a total of six transits. Each transit will simulate a microwave station-to-station hop of about 30 miles, the usual distance between such stations. A transit of 175 miles is the international reference distance for measuring the performance of microwave systems.

ENQUIRY CARD 63

* * *

COMPUTER AIDS SPEED EXAMINATION RESULTS

This year's results of the General Certificate of Education examinations for 60,000 candidates are nearly a fortnight ahead of schedule because of the use of an ICT 1301 computer to process the facts and figures. This number represents the first batch of about a quarter of a million results achieved every summer by the University of London School Examination Department, where the computer was installed at the end of 1962. A new systems analyst and a new team of programmers are responsible for getting the system working so well this year.

ENQUIRY CARD 64

NEW PRODUCTS—*Continued*

PHOTO-ELECTRIC CONTROL UNIT

Designed for ease of installation and maintenance, a photo-electric transistor control unit introduced by a British firm has a plug-in relay "drive circuit" and plug-in control relay. It is an exact and reliable means of controlling any function when a light beam directed at a photo-electric receiver is made, interrupted, or varied in intensity. It is also available in versions for use with resistance level, inductive proximity, capacitance proximity and temperature sensing probes, and as a delay and interval timer.

ENQUIRY CARD 65

* * *

IMPROVED GRAMOPHONE TURN-TABLES

A wooden pick-up arm and magnetically-operated automatic trip are among the latest techniques used in a new gramophone turn-table which was demonstrated for the first time in London last week. Use of wood for the pick-up eliminates the effects of "arm resonance" by ensuring that these occur at sub-audio frequencies. To prevent warping with changing temperature or humidity, the wooden arm is constructed with an aluminium channel along its length. This and other refinements built into the two turn-tables exhibited at the radio and television show in London (26th August to 5th September) are claimed to be major advances in eliminating friction and other factors which can reduce fidelity in the playing of records. The turn-table mat is made from electrically conducting rubber which neutralizes the static electric charge on records. The automatic trip mechanism is operated by magnetic repulsion—a device which removes all possibility of audible noise from record changing. The new turn-tables have been developed for world markets by Garrard Engineering Ltd., the British firm which has established a world lead in this field. The firm exports 75 per cent of output, a large proportion of which goes to the United States and Canada.

ENQUIRY CARD 67

* * *

PHOTO-ELECTRIC METER MONITORS LIQUID FLOW

Liquid flow monitoring equipment, which for the first time involves the use of photo-electric cells, has been developed by a British firm which claims that it has pioneered the application of light beams to flow monitoring problems. The equipment monitors the flow of liquid in a pipeline and provides an audible and visual warning when the density of the liquid carries from a pre-set point. This operation is of particular value in controlling effluent discharges into rivers and also to control processes involving the movement of liquids as in breweries and soft drink manufacture. The system consists of a viewing chamber which is inserted in the pipeline and is fitted with a light source on one side and a photoelectric cell on the opposite side. In this way a beam of light passes through the liquid as it flows through the pipe and is monitored by the photocell.

ENQUIRY CARD 66

* * *

FLOATING TRANSISTOR RADIO FOR SHIPS' LIFEBOATS

A new portable radio weighing 30lb. has been developed for use in ships' lifeboats by a British firm. Completely transistorised, the set, known as the Solas II, can be operated by one man, and transmits and receives on three different frequencies. During recent tests off Plymouth, southern England, signals were picked up in Malta. The set (which measures 27in. by 11⅛in. by 9in.) is built to withstand a 30ft. drop into the water. It floats and can be thrown overboard in an emergency and later retrieved from the sea when survival craft have been manned.

ENQUIRY CARD 68

* * *

RECORD DEMAND FOR ELECTRONIC EQUIPMENT

Overseas aviation concerns took a record £21,400,000 sterling worth of equipment from British electronics firms in 1963, it was announced recently. Statistics, produced for the first time at the Farnborough Air Show in Southern England, shows that the British electronics industry produced equipment during the year valued at £2000 million sterling, of which £569 million sterling went into aviation. Biggest sales in overseas markets were of ground radar and navigational aids, totalling £12,212,000 sterling. Similar equipment for aircraft with overseas operators was worth £1,544,000 sterling. Sales of ground radio communication equipment for use outside Britain totalled £6,935,000 with another £749,000 spent on airborne communication equipment. A statement by the Electronic Engineering Association said that in the air, electronics contribute to safety and punctuality by making the work of the aircrew easier. On the ground, the air traffic controller is being relieved of many of his routine tasks and is being helped by the introduction of improved radars and displays. The statement continued. "Perhaps the greatest compliment to the reliability of electronics is the way air crews have faith in their recording equipment. For many years now British military aircraft, the V-bombers, have been making automatic landings, with life being completely in the hands of electronics. There could be no clearer indication of reliability."

ENQUIRY CARD 69

Serviceman's Column

—*Continued from page 23*

separate 470K grid resistor was then provided.

2. The screen voltage was very high in relation to the plate voltage, being in the ratio of about two to one, and the screen bypass condenser was of extremely low size being only 100 PF capacity.

3. There was no form of contrast control anywhere in the video stage which meant that it was running "flat out" at all times (see circuit).

From a perusal of the above facts, together with a study of the symptoms and my previously mentioned findings, I came to the conclusion that the trouble was in fact due to the way in which the video amplifier valve was being operated. Working on this assumption the first thing I did was temporarily to reduce the value of the grid resistor to 10K. This immediately brought about a substantial improvement but I was still not quite satisfied. The next step was to reduce the screen voltage slightly and to increase the screen bypass condenser to a much larger size, .27μF. Without going very much deeper into the design and transferring the contrast control from the AGC to the video screen or cathode circuit there was not much more I could do in the way of effecting further improvements. I finally directly coupled the video grid to the high side of the diode load and removed the grid coupling condenser and resistor altogether. I am able to report that any sets thus modified have given no further trouble in this direction.

Some time after this the manufacturer brought out a later model of the same series and I found that the modifications described were almost exactly duplicated in it! Surely this then could be an example of where a "last resort" modification by a serviceman was entirely justifiable since it not only cured a trouble which could not be cured any other way but was subsequently incorporated by the manufacturers concerned.

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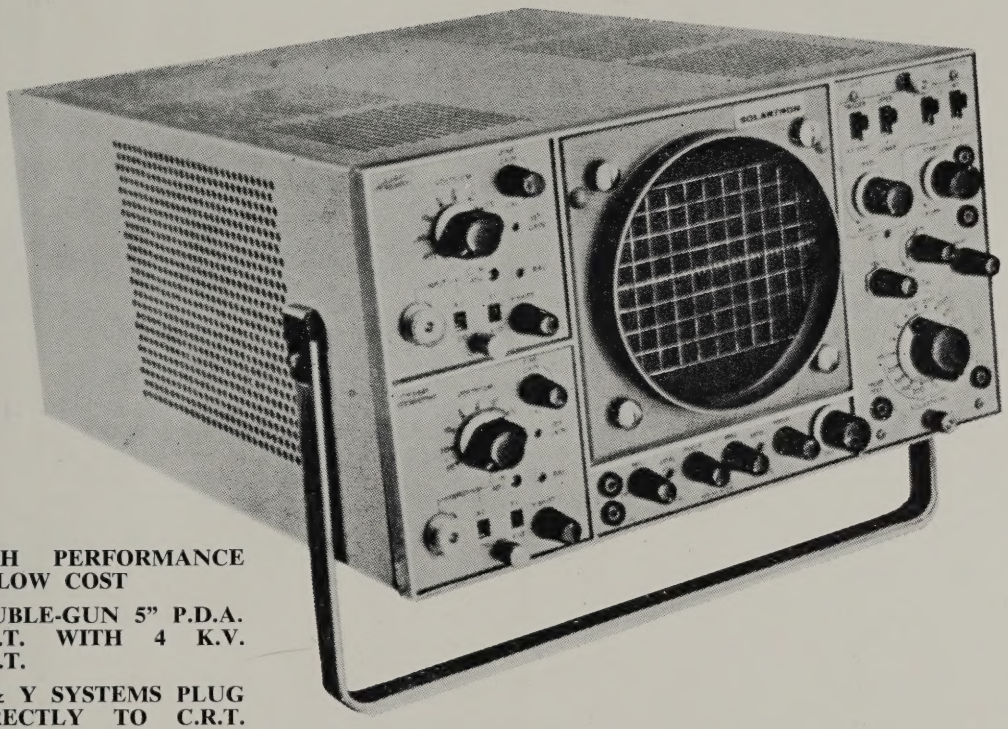

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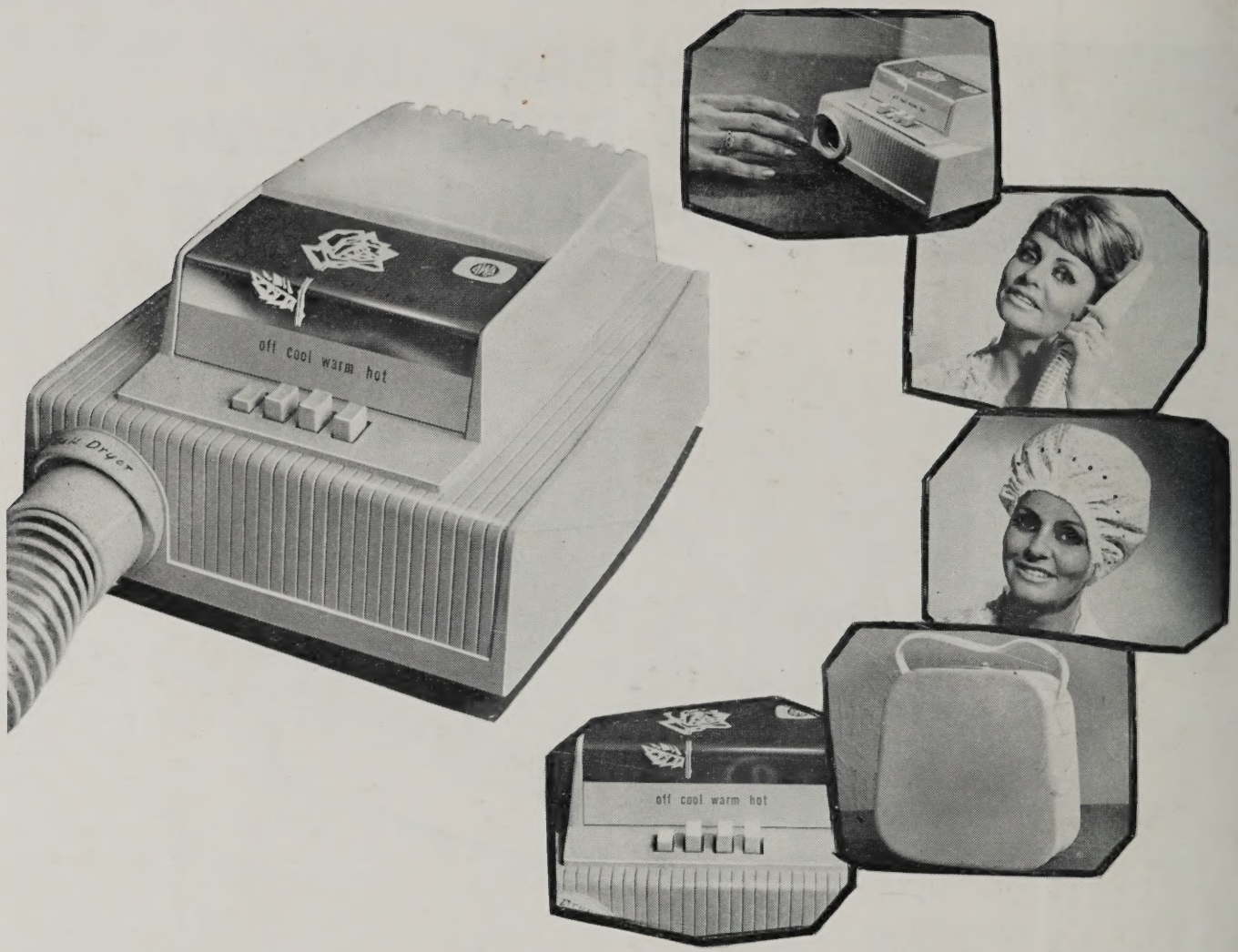

AWA introduce the first complete Hair dryer in New Zealand

AWA have commenced the manufacture in New Zealand of the Mannequin Hair Dryer. The Mannequin incorporates in the one hair dryer many of the features and advantages that are only found singly in competitive brands now on the New Zealand market. Features include the push-button choice of three drying temperatures, scientifically-designed cap for quick, comfortable drying, a nail-polish dryer and a unique "air-comb" attachment that solves the problem of drying close into the scalp. The Mannequin fits neatly into an attractive vanity case that is completely portable.

The retail price is £12/19/6.

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